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ABSTRACT

The organization, development, and evaluation of the Project on Elementary School Mathematics and Science are described in detail in this document. Part I covers the five-year history of the project. Discussions concerning the nature of the curriculum materials, the development of the materials, and the publishing and field-testing are presented in Part II. Details of the evaluation program are provided in Part III, including descriptions of the data-collection instruments, the overall design of the evaluation program, the sample, the organization of data, and the analysis of responses. Part IV assesses project accomplishments. Appendices include a list of the project staff, a collection of miscellaneous materials related to the process of selecting a commercial publisher, the data-collection instruments used in the evaluation program, and a list of the location of the trial centers. A bibliography of publications and other materials pertaining to the project concludes the document. (DT)

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PROJECT ON
ELEMENTARY SCHOOL
MATHEMATICS AND SCIENCE

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FINAL
REPORT

November
1976

University of Illinois at Urbana-Champaign

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UNIVERSITY OF ILLINOIS
at Urbana-Champaign

PROJECT ON ELEMENTARY SCHOOL MATHEMATICS AND SCIENCE

NSF PES 68-00442 (GW-4532)

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supported by the
National Science Foundation

FINAL REPORT

November, 1976

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(deceased, 1971)

Peter B. Shoresman, Professor of Science Education

Peter B. Shoresman
Signature of Principal Investigator

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PART I

HISTORY OF THE PROJECT

BEGINNINGS

Prior to 1965 most of the national curriculum development projects in the United States had been engaged in the creation of non-integrated curriculums. Little work had been done to develop materials which explicitly related different subject matter areas.[1]

In early August of 1965, The Cambridge Conference on School Mathematics and the Education Development Center (EDC) sponsored a meeting in Boston to discuss the possible correlation of mathematics and science in the schools. Representatives from a number of national curriculum development projects attended this two-day meeting, and it was eventually decided to hold an extensive workshop-style conference on the subject in late August of 1967.

During the winter and spring of 1966-67, several "warm-up" seminars were held in Berkeley, California, Cambridge, Massachusetts, and Urbana, Illinois. The reports which evolved from these meetings were circulated to prospective participants and formed the basis for the three-week conference at Pine Manor Junior College in Brookline, Massachusetts, August 21 - September 8, 1967. The Cambridge Conference on School Mathematics with administrative assistance from EDC organized this late summer meeting, with financial support being provided by the National Science Foundation.

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[1] At the time, the Minnesota Mathematics and Science Teaching Project (MINNEMAST) was the only notable exception.

At this meeting the efforts of the participants were focused primarily on the correlation of mathematics and science in the elementary schools. A report on this meeting speaks of the goals of the Conference:

> . . . a majority of adults today feel confused or threatened by everything scientific or mathematical. Our goal must be to correct this unfortunate state of affairs. . . . We specifically rejected the idea that we were trying to speed up the training of our scientifically talented youth or were aiming only at the college-bound child.
>
> Most of our thinking was therefore directed toward the elementary school program. High school courses in mathematics and science are often elective. Changes here affect only the minority, whereas changes in the elementary school curriculum affect almost everyone.[2]

The Conference did not confine itself, however, to discussing merely what should be taught. Its report also touched upon *how* an integrated mathematics-science curriculum might be taught:

> An integrated mathematics-science curriculum will not be easy to achieve. It will require vastly more experimentation than has yet been done by any of the science or mathematics curriculum groups. We believe that it will require a fundamental change in the style of school instruction. We have in mind a system of semi-individualized instruction based on a large number of small units to be worked through by individual pupils or small groups.[3]

And the Conference suggested a way in which such curriculum development might be carried on:

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[2] Education Development Center, Inc., *Goals for the Correlation of Elementary Science and Mathematics*, The Report of The Cambridge Conference on the Correlation of Science and Mathematics in the Schools (Boston: Houghton Mifflin Company, 1969), p. 5.

[3] *Ibid.*, p. 9.

> Larger or more affluent school systems might elect to designate one school (or even a few classes in one school) as a model school (classes) in which the initial steps toward a truly integrated mathematics-science curriculum could be tested intensively with the use of existing materials and units. Less affluent systems might elect to begin by adopting one or two mathematics-science units immediately, and to expand the program by the gradual addition of further units each year. The addition of one new mathematics-science unit by each teacher each year would indeed seem modest by almost any standard, but would exert a substantial impact on the nature of instruction at the elementary level in a relatively few years.[4]

The Project on Elementary School Mathematics and Science (PESMS) has been an attempt to fulfill these goals and others besides.

* * *

In the spring of 1967, the Champaign (Illinois) Community Unit School District No. 4 Board of Education appointed the Equal Educational Opportunities Committee to consider the issue of desegregating the Champaign schools. A year later, in the spring of 1968, the Committee submitted its report which advocated transforming the Booker T. Washington Elementary School into a "model" or "magnet" school.

This previously all black school, located in a low socio-economic neighborhood in northeast Champaign, was to be

> . . . discontinued . . . as a regular attendance center, [and] be reestablished in the fall of 1968 as an elementary attendance center with pupils to be admitted on a voluntary basis . . . from the entire Unit 4 area. While administrative and curricular control would remain with Unit 4, certain aspects of the instructional program would be developed cooperatively with the University of Illinois.[5]

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[4] *Ibid.*, p. 91.

[5] Robert L. Cooley, *Washington School Program* (Champaign, Ill.: Champaign Community Schools, March 11, 1968), p. 1.

It was felt that establishing such a school with a "superior curriculum" and staffed by teachers who possessed a "strong willingness to develop innovative practices" would help to facilitate Unit 4's desegregation efforts by attracting white students to this area of the district. In addition, the school district also saw such an experimental school as providing a center for the in-service education of teachers. Teachers would be assigned to Washington School for three to four years, then be rotated back into the other schools in Champaign. Through the influence of the University staff in the building, it was hoped that the teachers would become acquainted with new teaching methods and materials and then, upon their being rotated, would disseminate these ideas to other teachers.

Administratively, the Washington School was structured such that the principal would function in the same capacity as any building principal, and relate to the personnel of the district in the same fashion as other principals.

While Unit 4 saw the school as providing help in desegregating the district and supplying in-service training for local teachers, the University of Illinois Curriculum Laboratory viewed the venture from a slightly different perspective. The University saw this as a rare opportunity to produce curriculum materials within the context of a public school setting. Immediate feedback would always be available by which to judge the feasibility of innovations developed.

* * *

The late Professor Max Beberman, Director of the Curriculum

Laboratory and the organizer and first director of the Project on Elementary School Mathematics and Science, established in the spring of 1968 a Mathematics and Science Advisory Committee to suggest areas for exploration by the University staff to be assigned to the Washington School. This committee consisted of the following individuals: Charles Bell (mathematician, Case-Western Reserve University), Hilton Bialek (psychologist, Washington University), Robert Davis (mathematician and Madison Project director, Syracuse University), Abraham Flexer (biologist, Harvard University), Robert Karplus (physicist and Science Curriculum Improvement Study director, University of California at Berkeley), William Lister (mathematician, SUNY at Stony Brook), Earle Lomon (physicist, MIT), and Robert Wirtz (mathematics educator).

In the spring of 1968, Beberman made a trip to England visiting primary schools to investigate the "new" approach to mathematics which was being followed. This approach, which was influenced by the work of the Nuffield Mathematics Project, made a considerable impression on Beberman and caused him to reevaluate some of his ideas for the project at Washington School. He was intrigued by the way in which mathematics was being taught in these schools--the active involvement, the manipulation of materials, the self-direction and independence of the children, and the child-centered philosophy of the teachers. This trip was to have a large influence on the eventual evolution of the program at the Washington School.

Also in the spring of 1968, Beberman and Professor Peter B.

Shoresman, science specialist of the Project, traveled around the United States visiting several of the national curriculum development projects--principal among which were the Science Curriculum Improvement Study and the Elementary Science Study. Through these visits Beberman and Shoresman attempted to gain an insight into the directions other curriculum development projects were then taking and the techniques they were using in the pursuit of their goals.

By June of 1968, PESMS had begun to take shape. The meetings of The Cambridge Conference on School Mathematics in 1965 and 1967 had helped to provide the impetus for investigating an integrated mathematics-science curriculum for elementary schools and had suggested the use of a "model" school to aid in this work. The Champaign school district had agreed to provide a school where such curricular experimentation and innovation could take place. Trips to England and to curriculum development projects in the United States had helped to generate ideas about the type of instruction that might occur in such an experimental school and how such development work might be organized and begun.

* * *

In September 1968 the University of Illinois formally joined with the Unit 4 schools in initiating and operating the Washington School Project. That fall the Washington School, a kindergarten through sixth grade elementary school, had an integrated student population of some 425 children and an integrated staff of 16 classroom teachers, plus supportive staff including remedial, art, music, and physical education teachers, a part-time librarian, a part-time psychologist, and a part-time social worker. Approximately 25% of the students were black. All students were volunteers and most were transported to and from school in district buses. The student population contained children from almost all of the neighborhood districts within the school system. The classroom teachers were also volunteers.

During the period from September 1968 through June 1973, the University of Illinois assigned a large number of research workers to the Washington School Project. These included specialists in science, mathematics, industrial arts, reading, movement, creative arts, and early childhood education. Many of these staff members were permanently officed at the school. The University also installed a dozen PLATO terminals for computer-assisted instruction and renovated an old garage behind the school for use as a design laboratory for children and staff. PESMS was the largest and, with the exception of PLATO, the most enduring of the many projects which operated within the framework of the Washington School Project.

General decisions related to the activities carried on at the school were made by a seven-member Advisory Council consisting of three administrators from the central office of the school system, three University faculty members, and the principal of the school. In addition, classroom teachers and parents had an elected representative who served on the Council in a consultative, but non-voting, capacity.

From the standpoint of the Champaign schools, the Washington

School was to serve as a system-wide center for in-service training and for the development of new and improved materials, programs, and organizational structures for the elementary school level. Products were to be disseminated (1) by the reassignment of Washington School teachers after a three- to four-year tenure in the school, (2) by the interaction of current Washington School classroom teachers with their professional colleagues throughout the school system, and (3) through the utilization of the school as a focus for in-service education, where teachers and principals could observe new ideas being tried out and where they could participate in workshops on a variety of topics.

The expectations of the University corresponded to the customary categories of research, teaching, and public service. University faculty members and graduate students used the school as a place to study new teaching methods, new arrangements of subject matter, and new ways of utilizing professional personnel. Faculty assigned to the school who also taught courses to prospective teachers used the school as a place for their students to observe and participate, and as a source of ideas for the organization and content of their University courses. Finally, the University's participation in in-service training work and in the development of innovative teaching materials and practices constituted a service to the local school district as well as to other schools in the nation that adopted some of the ideas generated.

THE FIRST YEAR (AUGUST 1968 - JUNE 1969)

Activities of PESMS's first year were supported financially by monies made available from State funds and by allocations of released time granted to senior members of the University staff. The initial effort of the Project was a two-week workshop, from August 26 to September 6, 1968, for those teachers who had volunteered to teach at the Washington School. Morning sessions of the workshop were devoted to examining new mathematics materials to be used during the coming year and were conducted by Beberman and Robert Wirtz. The afternoon work was focused on interacting with a wide variety of science materials and was supervised by Shoresman and Professor Charles M. Weller.

PESMS work during the early months of the 1968-69 school year was largely a "getting-the-feet-wet" type of experience: A wealth of mathematics and science materials had been purchased, and many hours were spent working with small groups of children trying to assess its educational potential. Although there was some attention paid to general methodology and development work at this time, most efforts were directed toward the integration of mathematics and science, with considerable emphasis being placed upon manipulative materials as opposed to strictly paper and pencil work.

The mathematics program was based primarily upon the textbook series *Math Workshop* (Encyclopaedia Britannica Press) and related activities, while the science program focused on units selected from the Elementary Science Study, the Science Curriculum Improvement Study, and the Elementary-School Science Project (University of Illinois). The basic objective of the latter program, in addition to integrating science with mathematics, was to actively involve children with natural phenomena, stressing that nature itself, not books or other "secondhand" sources, should serve as the main source of knowledge.

Some small beginnings in curriculum development work were made during this school year. Dr. T. Thacher Robinson devoted a good deal of his time to the initial development of what later became the Project publication *Electricity and Reasoning*. Additionally, Robinson expanded upon the Papy Mini-computer, illustrating, in a teacher's manual he wrote, broad uses for this simple device. Also, Professor Peter Braunfeld worked with the mathematical games *Begriffsspiel* and *Formenspiel* with kindergarten and first grade children, as well as doing some development work on games designed to improve arithmetic skills. Toward the end of the year, PESMS emphasis had broadened to include consideration of methodology as well as content in its development work.

THE SECOND YEAR (JULY 1969 - JUNE 1970)

In its second year of operation, PESMS was principally funded by the National Science Foundation, with additional funds coming from State sources. In August of 1969 Edith Biggs, a primary school mathematics specialist from England, spent a week with some of the Washington School teaching staff developing activities in mathematics. Miss Biggs later spent three weeks in November at Washington School, devoting her time both to assisting teachers in developing mathematical topics and in working with them and their children in the classroom. F. Frank Blackwell, also from England, likewise served as a consultant at Washington School in October, 1969, directing his energies to the development of the "integrated day" approach. Like Biggs, Blackwell also worked with teachers before, during, and after school in order to illustrate his techniques.

A third consultant from England, Marianne Parry, also spent two days at Washington School, talking about interest centers and the language experience approach to the teaching of reading and writing to kindergarten children. These three consultants, especially Biggs and Blackwell, exerted a great influence on the course of thinking of the Project, for--as noted in the 1970-71 proposal to NSF (page 2)--the fundamental research objective at the Washington School became "the development of a total educational program which cares for individual differences and does so primarily through 'active learning' (after Biggs) and through integrating themes (after Blackwell)."

The second year's science program, like that of the first year, consisted for the most part of a "back-up" program based on the Elementary Science Study, the Science Curriculum Improvement Study, and the Elementary-School Science Project. However, the emphasis had begun to shift toward a variety of innovative topics arising from the interests of the children and the teaching staff. The back-up program had indeed taken on the role of a springboard, and it was anticipated that the science curriculum would increasingly become a function of in-house development. In addition to commercially available science materials, greater use was made of raw materials, such as cardboard, and other, more versatile commercial products.

Project staff development work also became more prominent. Robinson, continuing work with electricity begun the previous year, developed approximately forty activity cards, each of which had undergone extensive trial with children before reaching final form. Braunfeld also continued his work with kindergarten and first grade children on *Begriffsspiel* and *Formenspiel*, and collaborated with Sylvia Pattison and a third grade class to study water.

Another area borrowed from the British infant schools--movement--was also begun in the fall of 1969. Margaret Rice, a British graduate student in education who had worked in English schools, began working with a few of the primary classrooms on movement. As the year progressed, her work came to include integrating various other topics with movement. Eventually, she spent part of her time assisting teachers with the integrated day approach as well.

Constructional activities at Washington School were also expanded when the University of Illinois provided funds for a design laboratory to be housed in a large vacant building adjacent to the rear of the school. Also, because of a greater use of manipulative materials, the corresponding need for staff work space, and the influence of British "teacher centers," a Project "resource center" came to be seen as necessary, and plans were made for its establishment.

THE THIRD YEAR (JULY 1970 - JUNE 1971)

Supported primarily by the award of a Guggenheim Memorial Foundation Fellowship, Beberman traveled to England in September of 1970. There, he focused his attention on how British teachers are prepared, how in-service courses are handled, how teacher centers are established and maintained, and--most importantly--how head teachers and other educators bring about changes in schools. Accompanying him on this trip, and partially supported by National Science Foundation monies, were four other University staff members--Sylvia Pattison (mathematics education), Claire Walker (science education), Sister Louise Lutz (mathematics/art education), and Martha Hamilton (educational administration).

This trip epitomizes a technique frequently used by the Project in its early years. Before deciding on a specific course of action, members of the staff would visit schools and/or projects and observe the procedures used by others who, in the Project's estimation, had successfully come to grips with the area in question--whether it be developing curriculum, training teachers, or changing educational systems.

From September 8 through October 5, 1970, Elwyn S. Richardson, a specialist in creative arts from New Zealand, visited Washington School. Richardson worked with the teaching staff in their classrooms, suggesting and demonstrating ways in which a creative and language arts program could be approached in an open classroom setting. In March of 1971, Richardson returned to Washington School for one more week of consultation.

During this year a number of development projects were initiated, several examples of which will be briefly cited: A Program in Functional Language Arts was conducted on a small scale by Professor Edwin C. McClintock of the General Engineering Department at the University of Illinois. This work was done in one sixth grade classroom in an attempt to improve children's ability to use language, particularly with respect to interpreting and conveying ideas in science, technology, and mathematics. Sister Louise Lutz, a doctoral student in mathematics education, conducted some in-service training workshops for several Washington School teachers on mathematics/art correlations. Gary Knamiller, a doctoral student in science education, worked in several primary classrooms examining ways in which children conceptualize scientific phenomena. Joella Gipson, a doctoral student in mathematics education, worked with students of varying ages and abilities on developing an approach to teaching probability and statistics to young children.

Very little of the work mentioned in the preceding paragraph was supported by funds granted to PESMS by the National Science Foundation. However, it is hoped that by mentioning these projects, some impression will be conveyed of the great amount of activity that was going on at the Washington School. It was within such an atmosphere of constant activity, experimentation, and innovation that PESMS carried on its work of developing integrated mathematics/science materials for use in open classrooms.

In October of 1970, Beberman returned from England for a one-week stay. During this time he met with the staff of the PESMS Resource Center. It was his suggestion that the staff focus its efforts for the rest of the year on conducting workshops for the Washington School teachers. These workshops would center around commercially available science units for which the staff had developed mathematical adjuncts. The purpose of the workshops was to provide a guided setting within which teachers could become acquainted with these ways of relating mathematics and science. No plans were made for developing completely original curriculum materials.

Beberman returned again from England in January of 1971 and sat in on one of the workshops described above. He suggested after the workshop that the staff consider developing new curriculum materials for use in future sessions. Beberman then left to return to England, where upon arrival he suffered a fatal heart attack.

Shoresman was named the Acting Director of the Project for the remainder of the school year and became the Director in the summer of 1971.

Since Beberman was to write the proposal for the next year's funding, the PESMS staff was forced to spend a hectic six weeks attempting to pull together reports and other data so that the proposal might be submitted on time. It was during this time that the Resource Center staff produced two booklets--*The Mini-Workshop* and *Teacher's Guidebook for Mathematics-Science Integrations for the Elementary Science Study Units "Sink or Float"* *and "Clay Boats"*--as examples of the type of work PESMS hoped to do in the year ahead.

In April of 1971, Shoresman traveled to England as part of his sabbatical leave from the University of Illinois. During his six-week visit, he studied infant school education, serving as an "assistant teacher" in an infant school. The main focus of his studies was on science and mathematics education.

In early June Shoresman returned from England and the Project staff began making plans for the upcoming Summer Planning and Writing Conference.

During the year the emphasis of the Project underwent a significant evolution. At the start of the year, PESMS had directed its efforts toward the in-service training of teachers via workshops. These workshops at first centered on using existing science units to which mathematical adjuncts were added. By the end of the year, workshops were still the focus; however, curriculum materials were now being actively developed by the Project staff. By the end of the Summer Conference, the focus was squarely on the production of curriculum materials, with in-service training becoming of secondary importance.

PLANNING AND WRITING CONFERENCE (SUMMER 1971)

Supported by funds from the National Science Foundation, PESMS organized and conducted a Planning and Writing Conference in the summer of 1971 at the Washington School, from June 21 to August 13. The major purpose of the workshop/conference was to involve elementary classroom teachers in writing teacher curriculum guidebooks with a special emphasis on the integration of mathematics and science.

Seven teachers from Washington School and four from other Champaign schools participated in the conference, the Washington School teachers being paid a stipend to act in leadership roles. In addition, all participants were afforded the option of receiving University of Illinois course credit for their work during the summer. Shoresman was the director of the conference, and twelve University staff members were available to lend assistance to the teachers if they wished to receive any. Three visiting consultants--Edith Biggs, Frieda Ployer, and Dora Whittaker--spent two weeks each at the school, offering suggestions for teaching in open classrooms and consulting with the teachers on the development of mathematics-science materials.

From applications returned by the parents of first through fourth graders, the Project selected 60 children to take part in the workshop. Although all of these children were from Champaign, none had previously attended Washington School. They were selected to provide a wide geographic distribution from the district as well as an equal number of boys and girls at each grade level.

During the first two weeks of this eight-week conference, the teachers conferred with University staff members and the first of the three consultants--Dora Whittaker--whenever they felt that they needed to talk with these people. The teachers during this time began designing the curricular materials which they wished to develop and try out.

The children attended the Washington School from 9:00 a.m. until noon from the third through the sixth week. The participants were thus able to try out their materials with elementary school children and evaluate their effectiveness, revise them, and then try them out again. During the third and fourth weeks, the second consultant--Frieda Ployer--was present to help teachers with mathematics and science activities.

During the seventh and eighth weeks of the workshop, the participants completed the writing of their curriculum materials (working papers). Edith Biggs consulted with the teachers during the sixth and seventh weeks focusing on manipulative approaches to mathematics.

When they were not serving as resource personnel, many of the University staff also worked on developing their own curriculum materials. They became involved in the same types of activities in which the participants were involved; as a rule, they worked alongside the participants rather than supervised them.

The following working papers were developed during the summer conference (those marked with an asterisk were later printed and trial-tested):

Magic Squares as a Discovery Springboard

The Outdoor Classroom

**Do You See What I See?*

**It Sure Doesn't Taste Like School*

**An Approach to Symbolic Representation*

Removing the Magic from Multiplication

Shapes with String

A Light Box

**Apollo Pay-Off*

By the end of the workshop/conference, the focus of PESMS had come clearly into view. The Project from this time on would channel most of its efforts into producing and disseminating teacher guidebooks emphasizing mathematics-science integrations for use in open classrooms.

THE FOURTH YEAR (SEPTEMBER 1971 - JUNE 1972)

Supported by funds from the National Science Foundation and the University of Illinois, PESMS devoted most of its efforts during the 1971-72 school year to producing curriculum guidebooks and preparing strategies for evaluating these guidebooks. Washington School continued to receive hundreds of visitors from throughout the state of Illinois and the nation. In addition, the school also served as a center for in-service education for the Champaign Community Schools. More than ten workshops were presented by members of the University and teaching staffs for other local teachers. But the major efforts of the Project were focused on the offset reproduction of the booklets developed during the Summer Planning and Writing Conference, the dissemination and evaluation of these booklets, and the creation of still additional curriculum materials.

During this fourth year of the Project, the following materials were developed by members of the University staff (those marked with an asterisk were later printed and trial-tested):

**Electricity and Reasoning*
Polyominoes and Paraphernalia
Real Structures
A Hole in the Wall
**An Introduction to Linear Measurement with the Metric System*
**Up, Up, and Away*

**Line Symmetries of Polygons*

Marble-Chute Computers

**Cheap But Interesting*

Kites and Gliders

Dissection in the Elementary Classroom

Water Topics

During this year the Washington School served as a major development and test center for the Unified Science and Mathematics for Elementary Schools (USMES) project sponsored by the Education Development Center. Robinson, as well as the staff of the school's Design Laboratory and four classroom teachers, worked closely with Professor Earle Lomon (EDC/MIT) and his staff on a number of common projects.

Beginning in September of 1971, Shoresman and Ronald V. Jones, the Project editor, began readying the first manuscript (*It Sure Doesn't Taste Like School*) for offset reproduction. In November this booklet was printed. By April of 1972 three more booklets had been printed. All of these booklets, as well as all other curriculum guidebooks emanating from PESMS, were in the form of preliminary editions and only limited quantities were printed.

During the winter of this year, the Project also created its first instrument for assessing the effectiveness of its materials. This instrument--the Teacher Reaction Form--was later revised and used in the following year's evaluation efforts.

In the spring of 1972, at the National Science Teachers Association Convention in New York City, an attempt was made to recruit elementary classroom teachers to try out and evaluate PESMS materials. The Project was successful in soliciting interest from approximately 200 educators.

Teacher Application Forms were then mailed to those teachers who had expressed an interest in taking part in the Project's evaluation program. This constituted the first major step in PESMS's large-scale evaluation effort which was to become the most important aspect of Project work during the next school year.

WRITING CONFERENCE (SUMMER 1972)

During the summer of 1972, another writing conference was held at the Washington School, sponsored by the local school district and the University of Illinois. National Science Foundation funds were not used to compensate the teachers involved or to finance the four-week children's program. This program, operated in the morning, served to make children available to the participants, although--as was the case with the previous summer's writing conference--the primary concern was to provide a fruitful educational experience for the students.

The teachers' work included the development of written materials to be used for in-service training in the coming year as well as the refinement of working papers begun the previous summer. In addition to working on their own projects, the teachers also contributed to the children's program by setting up learning centers in mathematics and science. Two University classes, including about twenty students, also worked with the children. The Project staff was available for consultation to both the participants and the children's program.

The greater part of the University staff's time was devoted to completing work on curriculum booklets begun the previous summer, and planning a dissemination and evaluation program for PESMS materials. Three more booklets were printed during this time. Two staff working papers on dissemination and evaluation were also written during the summer: The first identified PESMS goals and aspirations, and discussed dissemination and evaluation considerations; the second mapped out a more detailed evaluation program and suggested specific operating procedures.

THE FINAL YEAR (SEPTEMBER 1972 - AUGUST 1973)

The fifth and final year of the Project on Elementary School Mathematics and Science was carried on by a greatly reduced University staff. Whereas in the past as many as thirty University personnel had taken an active part in Project-related work at Washington School, during the final year only seven University people were employed. Of these seven, only the secretary and the editor were full time. In addition, there was a large turnover in the teaching staff at the school, as the school district chose to rotate out, all at once, a large number of teachers who had taught at the school for three or more years.

During this year the final two PESMS booklets were printed. In addition, three short booklets produced by Washington School teachers during the 1972 Summer Writing Conference were printed and distributed locally. The Project did not initiate the development of any new curriculum materials this year, but attempted, rather, to wrap up the work that it had begun in prior years. The emphasis of this final year was on readying all manuscripts for publication and printing as many of these as possible, conducting an evaluation of those booklets which had been trial-tested by classroom teachers across the nation, locating a commercial publisher for Project booklets, and beginning to compose the final report of the Project.

The major classroom trial and evaluation of Project materials was begun in the fall of 1972 and completed during the spring of 1973. (For a discussion of the evaluation program--instruments, sample populations, and results, see pages 51-81.)

Work also proceeded during this final year to implement locally a Washington School Project dissemination program. To this end, a number of workshops were conducted in the Champaign-Urbana area by the teachers who had participated in the 1972 Summer Writing Conference.

During the late winter and spring of 1973, PESMS attempted to identify a commercial publisher for the materials developed by the Project. In February a large number of publishing houses were sent a notification of the Project's publication plans. Thirteen companies expressed an initial interest in being considered, and in March these companies were mailed copies of the nine booklets that had been trial-tested, as well as summaries of other booklets the staff was still preparing for printing--*A Light Box*, *Marble-Chute Computers*, and the *PESMS Sampler*. Accompanying these materials was notification of and an invitation to a meeting in Champaign-Urbana on April 13 of all publishers wishing to explore an exclusive publication agreement. The representatives of five publishing houses attended this meeting at which members of the staff outlined the history and work of the Project, summarized the materials being trial-tested, and described evaluative feedback received to date. Despite commendations about the quality of individual booklets, no publisher chose to undertake the task of promoting and marketing PESMS materials. Although there have been communications with several additional publishing companies in the last few years, Project materials remain unpublished as of this date. (See Appendix B for a collection of materials related to the Project's efforts to select a commercial publisher.)

In January of 1973, the PESMS staff began to develop this final report. Shoresman and Jones supervised and edited the materials produced as well as participated in the actual writing of the manuscript. These two staff members continued work on the report through the summer and succeeded in compiling a rough draft of several hundred pages. The present report, a much edited and condensed version of this larger report, was submitted by Shoresman to the National Science Foundation in the fall of 1976.

OTHER FACETS OF THE WASHINGTON SCHOOL PROJECT

Pre-Service Teacher Training

During the term of PESMS at Washington School, University students in elementary education used the facilities to work with children in micro-teaching settings. This provided the students with opportunities to observe the reaction of children to new curriculum materials in activity-oriented learning situations. University students also had access to the Design Laboratory and the Resource Center, as well as to classrooms where observations could be made of programs incorporating subject matter integrations. Thus, the availability of the school contributed significantly to enhancing the teacher education program of the University of Illinois.

Graduate Assistant Involvement

Of the total number of University staff working on Project-related activities, a considerable proportion were graduate assistants enrolled at the University of Illinois. However intangible this may be, such professional personnel represent a definite product of Project activity. Over the five years of Project operation, approximately thirty-five graduate assistants were involved who are now employed in various roles throughout the United States and abroad. These individuals constitute a considerable potential for disseminating the ideas and materials generated by PESMS.

Visitors

From September of 1968 to June of 1973, a significant number of people visited the Washington School. There were classroom teachers, public and private school administrators, parents, school board members, curriculum specialists, and university faculty, undergraduates, and graduate students from many areas of the United States and quite a few foreign countries. A conservative estimate, based on the limited records available, would put the number of visitors to the school, in the five-year period indicated, in excess of two thousand.

PART II

CURRICULUM MATERIALS DEVELOPED

NATURE OF MATERIALS

All of the curriculum materials produced by the Project were developed in open classrooms with eventual implementation in open classrooms constantly in mind. All materials possess a mathematics and/or science emphasis. Sometimes the science grew out of initial work with mathematics; sometimes the mathematics grew from initial work with science; sometimes the mathematics and science started side by side and grew together. Sometimes there is much mathematics and little science; sometimes there is much science and little mathematics; sometimes there is a good balance of both mathematics and science; and sometimes it is difficult to determine what is mathematics and what is science.

Although PESMS's primary concern was the integration of mathematics and science experiences, correlations with other subject matter areas were constantly sought. Many booklets include an indication of possible extensions of the mathematics-science content into language arts, social studies, and the creative arts.

After the basic criterion of content validity had been met the ultimate criterion for publication was that our materials, as published, should be usable by any classroom teacher, with little or no further assistance from the developer. If the booklet presupposed teacher preparation in mathematics and/or science beyond that normally required for teacher certification, sections were included giving explanations of the content necessary for successful implementation.

In general, our development efforts seemed to fall into one or another of the following five categories:

1. Booklets presenting detailed content focusing on specific mathematics or science concepts: These materials are rather narrow in scope, exploring only a few concepts in depth, and are directed--for the most part--to intermediate grade children. Examples of this type of booklet are *An Approach to Symbolic Representation* and *Line Symmetries of Polygons* (see summaries in this part of the Final Report and the Bibliography).

2. Booklets broader in scope that #1 above, but focusing primarily on mathematics and science: Examples of this type of booklet are *Up, Up, and Away*, *Marble-Chute Computers*, and *A Light Box* (see summaries and Bibliography).

3. Booklets focusing on broad, interdisciplinary topics, but having strong mathematics-science correlations: Examples of such booklets are *It Sure Doesn't Taste Like School* and *Apollo Pay-Off* (see summaries and Bibliography).

4. Booklets containing a potpourri of general science and/or mathematics topics that are primarily intended to extend or supplement class work in these two areas: Examples of this type of booklet are "Shapes with String" and "Model Cities" (see Bibliography).

5. Booklets describing techniques and/or apparatus designed in response to needs perceived in other booklets, emphasizing the utilization of certain types of simple, easily obtained materials, or evolving from specific design studies: Examples of this type of booklet are *Cheap But Interesting* and, to a lesser extent, "Real Structures" and "On Flying Kites" (see summaries and Bibliography).

Figure 1 summarizes the subject matter interrelationships and the end products described above.

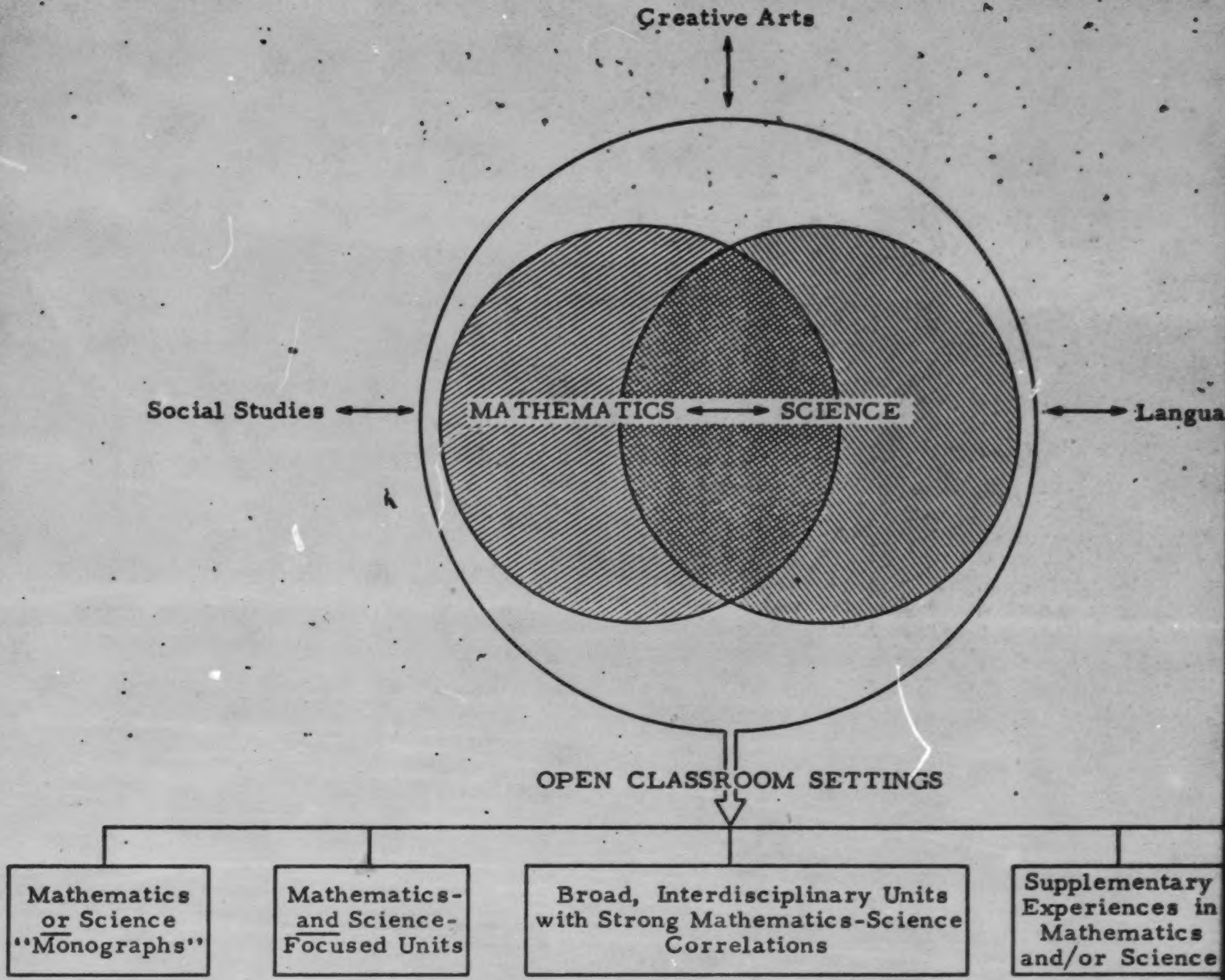
Creative Arts
Social Studies
MATHEMATICS
SCIENCE
Langua
OPEN CLASSROOM SETTINGS
Mathematics or Science "Monographs"
Mathematics- and Science- Focused Units
Broad, Interdisciplinary Units with Strong Mathematics-Science Correlations
Supplementary Experiences in Mathematics and/or Science

Fig. 1 Curriculum Materials Developed

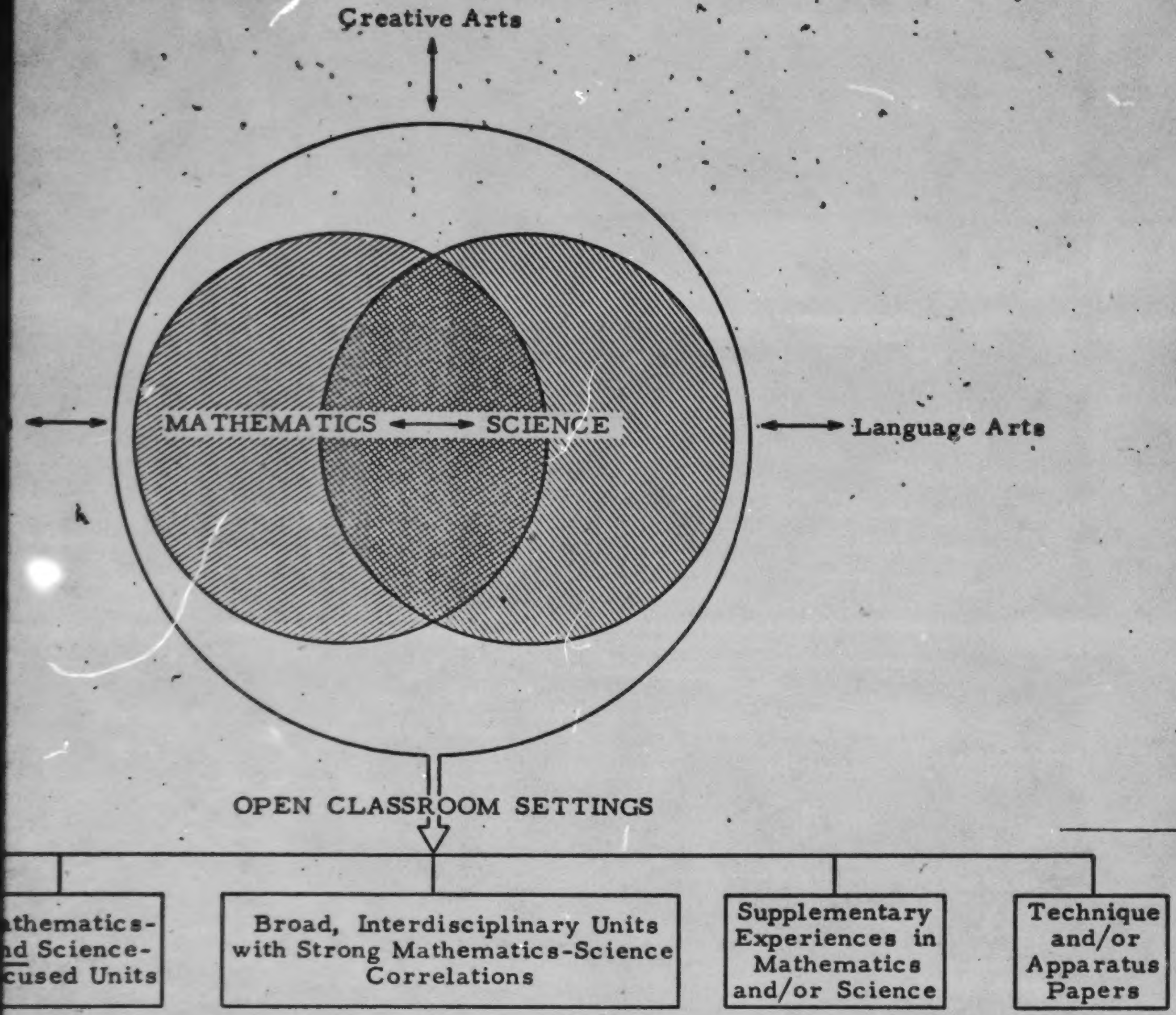
Creative Arts
MATHEMATICS
SCIENCE
Language Arts
OPEN CLASSROOM SETTINGS
thematics-
nd Science-
cused Units
Broad, Interdisciplinary Units with Strong Mathematics-Science Correlations
Supplementary Experiences in Mathematics and/or Science
Technique and/or Apparatus Papers

Fig. 1 Curriculum Materials Developed

DEVELOPMENT OF MATERIALS

Many different people were involved in the development process--mathematics and science educators, mathematicians and scientists, classroom teachers, and the children themselves. But the significant point of this development is that all materials were developed within a public elementary school. Close work with teachers on a day-to-day basis was a vital ingredient of all development activities and, in many instances, the teachers themselves generated new curriculum materials. Consultation about and review of these materials was provided by members of the Project staff and by subject matter specialists elsewhere in the University. At the least, teachers freely provided the University staff with useful feedback related to classroom tryouts. The ideal sought was for both teachers and Project staff to be equally involved in the necessary background research, the preparation of children's materials, the classroom trials, and the writing up of teacher guidebooks.

It was also realized that curriculum development by classroom teachers could be a very effective technique of on-the-job inservice training. This type of involvement tended to increase motivation to try out new ideas and also encouraged perseverance when implementation did not proceed smoothly. Furthermore, the interaction involved when working on a common project seemed to facilitate the development of new insights on the parts of teachers and University personnel alike.

A guiding principle of Project operation was that the most creative curriculum materials evolve from projects that build on the common interests of staff and children and, to this end, areas were constantly sought where these interests intersected. It was also found that each development project should have an explicit payoff for the children involved: they must learn something or learn how to do something that they did not know or could not do before. Furthermore, the mathematics and science content had to be valid, non-trivial, and--in the opinion of the developer(s)--suitable for children of the age range concerned. Activities were also to be designed with long-range as well as short-range goals in mind.

After the decision had been made to undertake a particular development project, time was spent by those involved in preparing preliminary materials (activity cards, apparatus, reference materials--the latter at both the adult and child level--and so forth) before classroom trials began. The heart of the developmental process itself was an intimate interaction of staff, children, and materials. During development, the normal procedures of the classroom were disrupted as little as possible. Generally, this was not difficult because of the informal atmosphere of most classrooms. Work was usually conducted in the rooms on a regular basis--sometimes with individual children but more frequently with large and small groups. This quite often took the form of classroom trial for a week or two, followed by a period of revising and writing. During the actual trials, anecdotal and photographic records of each session or activity were often kept.

Teachers and Project staff often met afterwards to evaluate what had taken place in the classroom. Much revision and rewriting occurred as a result of these trials and subsequent evaluations. When teachers were involved in all or several phases of the development work, released time was made available to enable them to write and to confer with Project personnel. Throughout this entire process, the developers worked closely with the Project editor in making decisions related to format, style, and possible illustrations for the preliminary editions. In addition, there were frequent informal consultations with colleagues where comments and technical assistance were solicited.

Manuscripts submitted for publication went through several important steps prior to printing. First, copies were distributed to subject matter and teacher education specialists, both within and outside the Project, to be reviewed for content validity and methodological feasibility. Rewriting, if necessary, occurred next and the manuscript was then subjected to initial editing for format, style, and mechanics. Next, art work and halftone photographs were prepared. One to several additional revisions of the manuscript were then typed--at times being returned to reviewers for final comment. Editing occurred again and final copy was then typed and proofread, art work mounted, and positions of photographs indicated. Printing was done by offset process using three different facilities in the Champaign-

Urbana area--the Work Experience Laboratory (WEX-LAB) of the Champaign Community Schools, the University Stenographic Bureau, and the University of Illinois Press. All preliminary editions were printed in small, single runs of approximately 300 copies each. The only booklet to be rerun was *It Sure Doesn't Taste Like School* for which 150 additional copies were printed.

The relationships involved and the procedures employed in the development process are depicted in Figure 2.

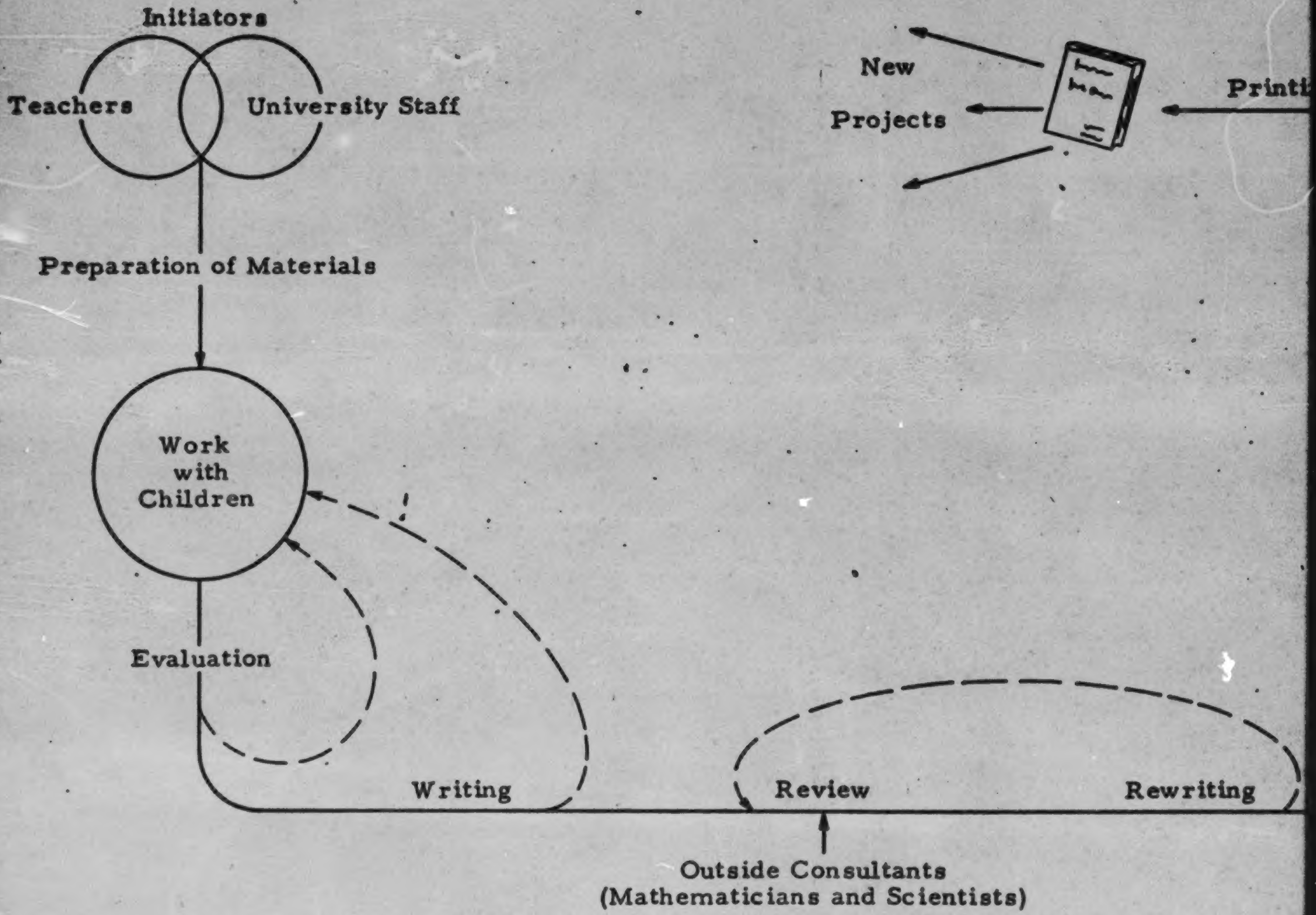
Initiators
Teachers
University Staff
Preparation of Materials
Work with Children
Evaluation
Writing
Review
Rewriting
Outside Consultants (Mathematicians and Scientists)
New Projects
Printi

Fig. 2 The Development Process

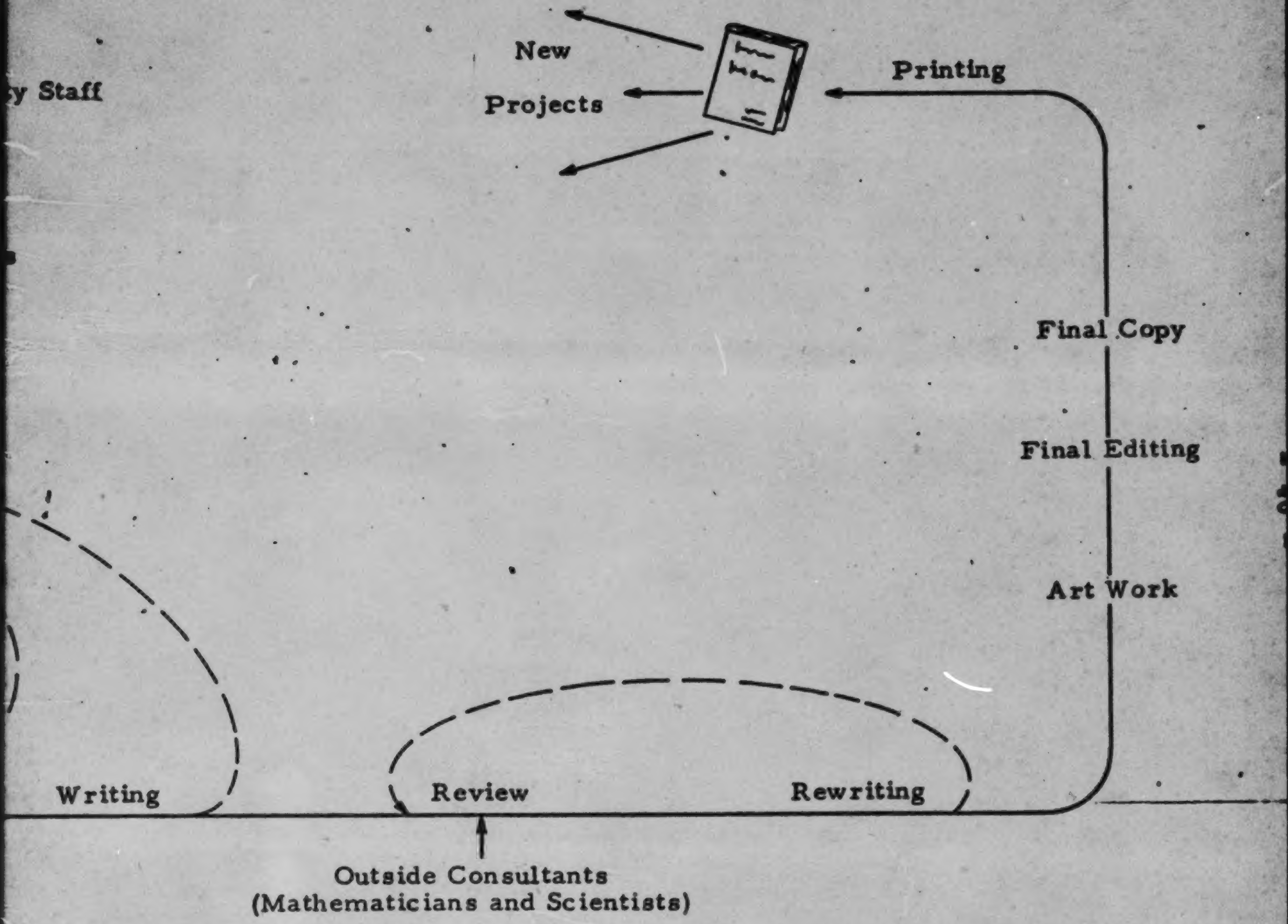
y Staff
New
Projects
Printing
Final Copy
Final Editing
Art Work
Writing
Review
Rewriting
Outside Consultants
(Mathematicians and Scientists)

Fig. 2 The Development Process

MATERIALS PUBLISHED AND FIELD-TESTED

During the 1971 Summer Planning and Writing Conference, and again in 1972, the Project staff undertook a content analysis of curriculum materials under development. A number of important mathematical and scientific themes were identified. For example, the notion of inequality, the four basic arithmetic operations, and various types of measurement appeared in a large number of booklets. Practical applications of principles, interactions, energy transformations, and changes were the most prominent scientific themes. Our assessment of the distribution of these content components in our materials is presented in Figures 3 and 4.

Also in 1972, the staff developed a set of suggested grade level placements for the twelve booklets we had hoped to field-test. Generally, a range of several to many grade levels was indicated for each booklet. A grade placement chart is displayed in Figure 5.

The Project on Elementary School Mathematics and Science generated manuscripts for approximately twenty-five teacher guidebooks. Only nine of these manuscripts reached the publication stage and were field-tested. On the pages to follow are presented brief summaries of these nine booklets. For a listing of other manuscripts completed but not field-tested, refer to the Bibliography at the end of this report.

UNITS

COMPONENTS	It Sure Doesn't Taste Like School	An Approach to Symbolic Representation	Up, Up, and Away	Marble-Chute Computers	Measurement	Removing the Magic from Multiplication	Line Symmetries of Polygons	Splash!	Dissection in the Elementary Classroom	Electricity and Reasoning	Apollo Pay-Off	Polyominoes, Pattern Logic, and Paraphernalia	Cheap But Interesting	Real Structures	Structures in Nature and in Man-Made Objects	Shapes and Discrimination	Reflections in a Magic Square	Kites and Gliders	A Light Box	The Outdoor Classroom	Magic Mirrors	Model Cities	Black Bag Photography	A Hole in the Wall
Sorting, matching, and classifying	●	●			●		●	●	●			●		●	●	●	●	●	●	●	●	●	●	●
Conservation	●	●			●			●			●							●	●	●				
Inequalities	●	●	●	●	●		●	●		●	●	●	●		●	●	●	●	●	●	●			
Operations (+, -, ×, ÷)	●	●	●	●	●	●		●			●		●		●	●	●	●	●	●		●	●	●
Measurement																								
Perimeter and length	●	●	●		●		●	●	●	●	●		●	●	●	●		●	●	●	●	●	●	
Volume, capacity, and weight	●	●	●		●			●	●		●							●				●	●	
Area			●		●			●					●			●		●	●		●	●	●	
Time and temperature	●	●		●				●			●							●	●	●			●	●
Angles			●	●			●				●		●	●		●		●	●	●	●	●		
Estimation and approximation	●				●	●		●	●		●		●		●			●	●	●	●	●	●	
Averages	●	●						●	●								●	●		●			●	
Ratio (fractions)	●	●	●		●		●				●		●			●		●			●		●	●
Proportion (direct and inverse)	●	●	●		●			●			●							●	●			●	●	●
Scale	●	●			●			●	●		●				●			●	●			●	●	●
Continuity and limits		●									●					●			●				●	
Fixing position		●									●					●			●	●	●	●		
Geometric properties of shapes		●	●				●	●				●	●	●	●	●	●	●		●	●	●		
Numerical communication	●	●		●	●	●		●			●		●			●	●	●		●		●		
Tabular communication	●	●			●		●	●			●		●			●		●	●	●	●		●	●
Graphical communication	●	●	●		●			●		●	●	●	●	●	●	●		●	●		●		●	●
Arithmetic in bases other than 10				●							●													
Logic									●	●		●	●					●			●			

Fig. 3 Mathematics Components of Curriculum Materials

UNITS

COMPONENTS	It Sure Doesn't Taste Like School	An Approach to Symbolic Representation	Up, Up, and Away	Marble-Chute Computers	Measurement	Removing the Magic from Multiplication	Line Symmetries of Polygons	Splash!	Dissection in the Elementary Classroom	Electricity and Reasoning	Apollo Pay-Off	Polyominoes, Pattern Logic, and Paraphernalia	Cheap But Interesting	Real Structures	Structures in Nature and in Man-Made Objects	Shapes and Discrimination	Reflections in a Magic Square	Kites and Gliders	A Light Box	The Outdoor Classroom	Magic Mirrors	Model Cities	Black Bag Photography	A Hole in the Wall
Changes	●			●				●		●				●		●		●	●	●			●	
Characteristics of living things	●								●						●					●		●		
Communities																				●		●		●
Conservation of matter/energy			●	●						●								●	●					
Energy transformations			●	●						●	●			●				●	●	●		●	●	●
Environments											●									●		●		
Equilibrium	●		●	●				●					●					●						
Frames of reference		●			●				●		●					●					●			
Growth and development	●								●											●				
Information theory		●		●					●	●														●
Interactions	●		●	●				●		●	●		●	●				●	●	●		●	●	●
Life cycles	●								●											●				
Model building				●		●	●			●		●					●							
Properties of objects	●	●			●			●					●	●	●	●								
Relative position and motion			●		●		●				●							●		●				
Symmetry			●			●	●		●			●			●	●	●	●	●		●			
Systems	●	●		●	●	●		●	●	●	●	●					●					●		●
Technology	●		●	●	●			●		●	●		●	●	●			●				●	●	●

Fig. 4 Science Components of Curriculum Materials

PROJECT ON ELEMENTARY SCHOOL MATHEMATICS AND SCIENCE

NAME OF BOOKLET	GRADE LEVELS FOR WHICH BOOKLET IS APPROPRIATE								
	K	1	2	3	4	5	6	Jr. High	Teacher Reference
An Introduction to Linear Measurement with the Metric System	x	x	x	x					
An Approach to Symbolic Representation	x	x	x	x	x	x	x		x
*Water Topics	x	x	x	x	x	x	x		x
Do You See What I See?		x	x	x					
It Sure Doesn't Taste Like School			x	x	x	x			
Up, Up, and Away					x	x	x	x	
Electricity and Reasoning					x	x	x	x	
Apollo Pay-Off					x	x	x	x	
*Polyominoes, Pattern Logic, and Paraphernalia					x	x	x	x	
*A Light Box					x	x	x	x	
Line Symmetries of Polygons						x	x	x	
Cheap But Interesting									x

*Not field-tested.

Fig. 5 Grade Placement Chart

It Sure Doesn't Taste Like School

This booklet can be used with second to fifth grade children and uses the topic of cooking to demonstrate how several subjects can be integrated around one central theme. The major sections of this booklet detail experiences in mathematics, science, language arts, social studies, and arts and crafts. Through an activity-centered approach, students engage in cooking activities while encountering such specific topics as graphing, fractions, poetry, writing, the history of cooking utensils, and mold gardens. The appendixes also include fourteen pages of recipes for use with the "unit" and nine pages of resource materials (books, records, and films) to aid the teacher in implementation.

An Approach to Symbolic Representation

Having a mathematical focus, this booklet delineates activities in three Piagetian-type developmental stages--concrete collections, pictorial representation, and abstract representation. This material can be used with children within the 5- to 12-year-old range. The activities emphasize the need to allow the child to progress at his own rate while also requiring that he use some forms of recording both to preserve his findings and to communicate them to others. Such forms of recording include mappings, ordering, tabulating, writing, and several types of graphing. Also included are check-ups which are to be used to ascertain levels of conceptual development.

Up, Up, and Away

Through photographs and illustrations, this booklet depicts the development of a study about tetrahedral kites with third and sixth grade classes. After a brief discussion of Alexander Graham Bell's extensive work with the tetrahedral principle, the booklet shows visually the progress of the children's work from initial models to some of the final kites. Mathematical concepts touched upon include surface area and volume of tetrahedrons, ratio, and indirect measurement of height.

Apollo Pay-Off

The intent of this booklet is to capitalize on the events of a flight into space and use them as a vehicle for relating science, mathematics, and creative arts. The activities focus on an actual flight to the moon and are designed for use with fourth through seventh grade children. These materials are especially appropriate for all Apollo series flights. With some modification, the booklet is applicable to space missions not of the Apollo series. Graphing, working in different scales, basic concepts of astronomy, painting, writing, movement, 24-hour time are only some of the activities in the booklet. (The Project also had available an audio tape of the liftoff of Apollo 16 which we volunteered to reproduce for any teacher who supplied us with a cassette or a reel of audio tape.)

Line Symmetries of Polygons

This mathematics booklet is intended for the upper grades. It deals with the line symmetries of polygons (primarily quadrilaterals) and serves to develop an understanding of the properties of the quadrilaterals through the use of tracing paper "proof." The booklet contains a series of activity cards for children and notes for the teacher.

Do You See What I See?

This booklet emphasizes an approach to education based on visual awareness. Its main objectives are to provide assistance to teachers in training children to observe and to synthesize the theories and practices of education and life. The writer has chosen to do this by using the study of shapes and symmetry in natural and man-made objects. The activities and lessons presented relate these concepts to other areas of the curriculum. The lessons were field-tested in an informally organized primary classroom. The methodology and the vehicles for learning, however, can be utilized at any grade level.

Cheap But Interesting

This booklet is perhaps best summarized by its subtitle-- *A Conglomeration of Gadgets and Gizmos Made Primarily Out of Junk Which May Be Useful in Your Classroom.* Brief statements of the ecological and educational value of constructional activities accompany several examples of easy-to-build, low- or no-cost gadgets. Included are designs for several mass balances, switches and other "batteries and bulbs" materials, a "magic mirror," and a "twirl-a-word." The emphasis is on suggesting possibilities rather than providing "recipes." A list of useful tools and hints on where and how to scrounge are also included.

Electricity and Reasoning

This set of materials consists of a set of short sequences of activity cards and a teacher's guide intended to develop the capacity of fourth to eighth grade children to analyze, design, and build simple electrical devices and systems (e.g., those having to do with lighting, burglar alarms, and communication). Supplies are for the most part inexpensive, and such components as battery and bulb holders, switches and relays, are made by the children, mostly from discarded tin cans. The short sequences are arranged in categories such as "switches" and "connecting several gadgets to one source of electricity," to be worked by the children as the various technical needs arise in the course of their larger design projects. The primary emphasis is on the discrete logical analysis of closed circuit paths and connections, rather than on the more subtle and complex quantitative aspects of electrical theory. The style of most of the cards is to ask the child to find a way to accomplish certain simple objectives with certain given components, and then to write a few sentences or draw a diagram describing how the problem was solved. (More than 78 activity cards and 33 pages of teacher's guide make up this "unit.")

An Introduction to Linear Measurement with the Metric System

This booklet focuses primarily on mathematics and is intended mainly for grades kindergarten through three. The student activities proceed from using non-standard measuring tools (hands, feet, sticks) to using calibrated metre sticks to measure lengths, widths, heights, and perimeters. Estimation is emphasized as one means to aid in the development of skills in measurement. Body measurement and introduction to use of fractional parts are some typical activities included. Students are also given opportunities to record and interpret data. A separate, multi-colored "game board" is provided to facilitate the playing of the estimation game *Estimo*.

PART III

EVALUATION PROGRAM

INTRODUCTION

A major facet of the Project's work during its final year was the evaluation of curriculum materials produced. This effort was undertaken because the Project felt an obligation to describe to the profession the reactions of classroom teachers to its work. In addition, since a type of curriculum development was being attempted which--to our knowledge--had previously been subject to little research (namely, teachers and subject matter specialists working together in a public school setting to develop integrated curriculum materials for open classrooms), it was felt that it was especially important to ascertain and to report the degree of our success or failure.

Many types of evaluative techniques were employed. Formative evaluation occurred throughout the life of the Project while materials were in the process of being developed. Constant interaction took place between Project staff, teachers, and children in an attempt to assess how materials might be best organized for classroom use. It was only after such back-and-forth discussions that the materials were written up in booklet form and edited.

During the editorial process, numerous conferences were held between the Project staff editing the booklets and the authors themselves. The refinements thus arrived at were then incorporated into the text. Frequently, a copy of this "edited" material was sent to readers outside the Project who had expertise in one of the areas discussed in the booklet. Meetings were then held with the reviewers and, later, their reactions shared with the authors of the booklets. Where necessary, additional modifications in the materials were made prior to printing.

After the materials were in print, several types of feedback were obtained. Occasionally, educators who had read our booklets provided us with unsolicited written reactions. In addition, observations were made by Project staff during the winter and spring of 1972-73 in several trial classrooms to determine how well the materials were being received and utilized by teachers and children.

The major evaluation efforts of the Project, however, occurred in the fall and winter of the 1972-73 school year and were focused on the written data received from classroom teachers across the country who had volunteered to take part in the Project's trial teaching program. These teacher-evaluators recorded descriptive data and their reactions on three instruments: the Teacher Application Form (TAF), which supplied background data on the community, school, and classroom environments of the teacher; the Teacher Reaction Form (TRF), which provided evaluations of the individual booklets; and the Teacher Questionnaires (TQ), which solicited information regarding the effect of the materials on the instructional setting (specifically, did the materials cause the teacher to become more informal in his teaching approach?).

INSTRUMENTS

Teacher Reaction Form

The format and content of the TRF were sufficiently general to enable its use with all booklets the Project anticipated field-testing. The first page of the form consisted of questions designed to elicit basic descriptive information related to the physical circumstances within which the booklets were used. It also asked the teacher to indicate his feelings about using the materials again. The second page contained thirteen questions about booklet attributes (e.g., clarity of goals, usefulness of suggestions for correlations with other curriculum areas, and accessibility of required materials). Teachers were asked to respond to these questions in terms of a five-point rating scale--"yes or almost always," "usually," "some or sometimes," "seldom," and "no or almost never." (For purposes of data processing, the ratings were "flipped" so that "5" instead of "1" constituted the highest rating an attribute could receive.) Finally, the third page posed four open-ended questions pertaining to such areas of interest as major problems encountered, revisions suggested, and specific student evaluation techniques used. (See Appendix C for a copy of this instrument.)

Teacher Questionnaire

The purpose of the TQ was twofold: First, the Project was interested in the way its booklets were being used in trial classrooms relative to each teacher's normal teaching approaches. Since the booklets were developed in open classroom, and were designed for use in open classrooms, we speculated that most teachers would have to make at least some adjustments in their teaching techniques to accommodate the informality of our materials.

Second, we wondered if teachers, as a result of using Project booklets, would become more informal in their teaching approaches in mathematics and science even when they were not using Project materials. We were curious as to the extent that teachers would find informality to be a more satisfactory and satisfying teaching style.

To get an "evaluation handle" on an informal philosophy in practice, the Project decided to define an informal classroom setting in terms of a set of physical criteria. Other indicators could have been included, but it was felt that physical manifestations of the learning environment would be the easiest for teachers to rate. These criteria were incorporated into an instrument which required the teacher to *look* at his classroom and his program and to *describe* what he saw. This permitted a more objective approach to the matter at hand than if the teacher had been asked to *judge* whether this or that aspect of his classroom was informal.

The TQ consists primarily of such "look" items. Each item is in the form of two statements, one depicting a formally organized classroom, the other an informally organized classroom. For each item, teachers were asked to rate their classrooms along a seven-point continuum between these two statements. Additionally, for each item, they were to respond on an "M" scale to describe their teaching of mathematics, on an "S" scale to describe their teaching of science, and on an "M/S" scale to describe their teaching of mathematics-science if these two subjects were taught together. The "formality/informality" directions were "flipped" at random to minimize response bias.

On the second (TQ_2) and third (TQ_3) questionnaires, teachers were instructed to place two marks on each item continuum. A circle ("O") was used to describe classrooms when Project materials were not in use; an "X" was used to describe classrooms when Project materials were being used. On the first (TQ_1) questionnaire, completed before any of our booklets had been received, teachers were directed to give only an "O" response.

For purposes of data processing, the most informal response to an item was assigned a value of "7". All tabled values reflect this assignment and should be interpreted accordingly. (See Appendix C for a copy of the Teacher Questionnaire.)

MECHANICS

Volunteers for the 1972-73 evaluation program were solicited in a number of ways. Many of the teacher-evaluators were recruited in the spring of 1972 at the National Science Teachers Association Annual Convention in New York City where the Project had set up a display of its materials. Sign-up sheets were available at the display for those wishing to receive more information about Project materials. Early recruiting efforts also included the identification of teacher-evaluators through professional contacts made by staff through the usual informal channels.

In May of 1972, approximately 250 elementary classroom teachers, principals, and subject matter supervisors were sent an informational package in which was included a Teacher Application Form to be used in volunteering to be a teacher-evaluator. (See Appendix C for a copy of this application form.) The applicant was to indicate on the form whether he wished to evaluate one or two booklets. In exchange for these evaluations, the Project agreed to supply all booklets free of charge. It was understood that teachers would supply any other materials required to teach the units selected. Each applicant was to list four booklets, in order of preference, with the assurance from the Project that every effort would be made to provide him with at least one of his first two selections.

Beginning in August of 1972, teachers who had returned a completed application form were sent Form 1 of the TQ. Notification was given that the first booklet would be sent for classroom trial as soon as the Project had received the TQ properly completed. A TRF and a TQ_2 accompanied each of these first booklets when they were sent to teachers. Upon receipt of these instruments properly completed, the teachers who had agreed to evaluate two booklets were mailed their second booklets along with another TRF, a TQ_3, and a Complimentary Booklet Form. The latter form gave teachers an opportunity to receive one or two other Project booklets, with no obligation whatsoever, in appreciation for their successful completion of the trial teaching program.

Table 1 summarizes the number of evaluation instruments returned; it also indicates the attrition of teacher-evaluators during the course of the evaluation program.

TABLE 1

NUMBER OF EVALUATION INSTRUMENTS RETURNED

Expressed interest in receiving further information about Project materials	250[a]
Returned Teacher Application Form	212
Successfully completed Teacher Questionnaire, Form 1 . .	161
Successfully completed Teacher Reaction Form 1	102
Successfully completed Teacher Questionnaire, Form 2 . .	85
Successfully completed Teacher Reaction Form 2	47
Successfully completed Teacher Questionnaire, Form 3 . .	40

[a] This figure is an estimate. Furthermore, it does not reflect the number of teachers who eventually became aware of the Project since it includes building principals, supervisors, and consultants who frequently duplicated the information sent to them and passed copies along to a number of teachers in their building or district.

DESCRIPTION OF SAMPLE AND ORGANIZATION OF DATA

Demographic and pedagogic information regarding the teachers who returned evaluation forms was gathered by tabulating data from the TAF. For example, of the 104 teachers included in our analyses, 16 were male, 88 female; 49 taught in self-contained classrooms, 27 in a team-teaching situation, and 28 within a departmentalized structure; 69 teachers saw themselves as being informal in their approach to teaching, while 35 saw their teaching styles as being "non-informal." (The location of trial centers returning data used in our analyses is indicated in Appendix D.)

The data received from teacher-evaluators was divided into three groups: (1) Those evaluators who had completed TQ_1, TQ_2, and TQ_3; this group was labeled the "Two Booklets" group; (2) those who had completed only TQ_1 and TQ_2; this group was labeled the "One Booklet Only" group; and (3) those who had completed at least one TRF. Included in the Two Booklets group were 40 evaluators, in the One Booklet Only group 45 evaluators, and in the group that returned one or more TRF's 102 evaluators. (The latter group was larger than the Two Booklets and One Booklet Only groups combined as there were teachers who returned a TRF but who did not return the associated TQ.)

ANALYSIS OF RESPONSES: TEACHER REACTION FORM

The Teacher Reaction Form was designed to solicit feedback related to specific characteristics of each of the nine Project booklets trial-tested. Teachers were instructed to complete the form as soon as they had finished a booklet or by a given deadline date--whichever occurred first.

Open-Ended Questions

In all, responses to open-ended questions on 159 TRF's were reviewed and summarized. This number exceeds by ten the number of TRF's from which rating scale data was taken. In order to allow time for optical scanning and computer processing, a cutoff date was established beyond which no further rating scale data was included in the sample analyzed; on the other hand, the responses to the open-ended questions were reviewed up to the time of the preliminary typing of this final report.

Examples of the type of analysis performed for the feedback received is presented below for the booklets *Do You See What I See?* and *Electricity and Reasoning*:

Do You See What I See?

Twelve replies; eleven would use it again and one would not (preparation for activities was considered to be too time-consuming).

The great amount of time needed to prepare materials for the lessons caused much comment. Where there was no aide to assist the teacher, this factor was deemed critical. Sporadic parent assistance made little difference; student teachers made some difference; and a regular teaching aide made the preparation bearable. Construction of the "Looking Booth" was particularly mentioned as being time-consuming.

Obtaining materials such as tri-wall and cameras was a problem. Only one person suggested that a kit should accompany the booklet, and this person doubted that this would make much difference. (Note: Teacher-evaluators attending a feedback meeting in Champaign-Urbana rejected the idea of a kit.)

The overall organization necessary to obtain materials, then plan learning experiences, was well above the norm. Presumably, on the second attempt at such a unit, some of the problems mentioned would disappear.

Electricity and Reasoning

Nineteen replies; eighteen would use the booklet again, one teacher was undecided.

There was an almost universal positive reaction to the individual activity card approach. The only criticism related to the cards was that they were too structured or too detailed. Teachers recognized their own lack of content knowledge but felt that the background information provided was quite adequate. Some difficulty in obtaining materials was evident, one suggestion being that a list of required materials be provided. Most felt that more than one set of activity cards was essential, especially for the easier sets.

It was indicated that some fifth grade classes found the material too difficult.

Responses to Rating Scale Questions

Introduction

Many teachers in the trial teaching program used and evaluated two booklets, and completed a TRF for each, the two TRF's being identical in form. Overall, a total of 159 TRF evaluations were completed and returned, with 149 being received in time to be included in the rating scale analysis. Of these, 102 represent an evaluation of the first (or only) booklet used by a teacher, while the remaining 47 represent an evaluation of the second booklet used by a teacher. Table 2 below indicates the number of evaluations processed and analyzed for each of the nine Project booklets.

TABLE 2

NUMBER OF RATING SCALE EVALUATIONS

Booklet	Number
It Sure Doesn't Taste Like School (SURE)	22
An Approach to Symbolic Representation (SR)	26
Up, Up, and Away (UUA)	13
Apollo Pay-Off (APO)	14
Line Symmetries of Polygons (LSP)	10
Do You See What I See? (DYS)	12
Cheap But Interesting (CBI)	22
Electricity and Reasoning (ER)	18
An Introduction to Linear Measurement (LM)	12
Total	149

Numerical data[1] for the TRF's was analyzed in three ways: (1) in terms of the individual booklets evaluated; (2) all first (or only) booklets evaluated versus all second booklets evaluated; and (3) all evaluations by informal teachers versus all evaluations by non-informal teachers (this classification was based on teachers' descriptions of their teaching styles on the TAF). Only the first of these analyses will be discussed in the present report. Means and standard deviations were computed for all items; means, standard deviations, and measures of reliability were computed for all booklets and groups.

The discussion to follow is based on an "inspectional analysis" of TRF data. In this analysis, an attempt has been made by Project staff to make some sense out of the great mass of data accumulated. From the outset, though, it must be cautioned that no tests of significance were performed on any of the differences discussed. As should be obvious from the array of means presented in Table 3 on the next page, the statistical testing of all differences would have resulted in an enormous number of individual analyses, the interpretation of which would have been virtually impossible. Nevertheless, it is felt worthwhile to call attention to some of the most interesting comparisons between booklet and item means. In this discussion, some liberty has been taken in speculating

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[1] When TRF's were received, teacher responses were first coded onto optical scanning sheets and checked to minimize human error. The data cards generated were then separated and analyzed on an IBM 360 computer, employing the MERMAC--Test Analysis and Questionnaire Package (Bussell, R. L., *et al. MERMAC Manual: Test and Questionnaire Analysis Programs, Written for the IBM System/360.* Urbana, Ill.: University of Illinois Press, 1971.). The Project is indebted to the Measurement and Research Division of the Office of Instructional Resources, University of Illinois at Urbana-Champaign, for its assistance in data processing.

TABLE 3

ITEM MEANS BY BOOKLET

Booklet	Item[a]													Booklet Mean	S.D.	Rel.[b]
	1	2	3	4	5	6	7	8	9	10	11	12	13			
SURE	4.91[c]	4.86	4.23	4.50	4.41	4.55	4.50	4.55	4.27	4.82	4.45	4.45	4.73	4.56	0.26	0.73
SR	4.54	4.62	4.11	4.50	4.27	4.31	4.65	4.42	4.46	4.46	4.24	4.38	4.11	4.42	0.37	0.59
UUA	4.08	4.23	4.25	4.08	3.85	4.15	4.62	3.77	4.08	4.38	4.44	4.23	4.29	4.18	0.37	0.81
APO	4.29	4.71	4.31	4.50	4.14	4.14	4.50	4.29	3.93	4.29	4.38	4.21	4.75	4.34	0.43	0.90
LSP	4.30	4.20	----[d]	4.30	4.10	4.10	4.90	4.80	3.70	4.60	----[d]	4.50	----[d]	4.35	0.88	0.95
DYS	4.75	4.83	4.13	4.67	3.92	4.33	4.33	4.58	3.75	4.75	3.38	4.50	4.27	4.35	0.26	0.66
CBI	4.27	4.32	4.39	4.45	4.05	4.18	4.73	4.09	4.45	4.27	4.20	4.45	4.50	4.33	0.40	0.86
ER	4.00	4.56	3.73	4.17	4.33	4.22	4.39	4.06	3.94	4.06	4.14	4.11	----[d]	4.16	0.36	0.83
LM	4.58	4.67	3.71	4.75	4.58	4.58	4.75	4.58	4.58	4.75	4.25	4.67	4.00	4.56	0.42	0.86
Item Mean	4.43	4.57	4.15	4.44	4.20	4.30	4.59	4.33	4.19	4.47	4.24	4.38	4.48	4.37[e]		
S.D.	0.68	0.64	0.77	0.66	0.74	0.79	0.60	0.75	0.92	0.76	0.82	0.71	0.74			

[a] N = 149 for all items except #3, #11, and #13. N_3 = 105; N_{11} = 104; and N_{13} = 84.

[b] Split-half reliability (odds versus evens), computed by Spearman-Brown prophecy formula.

[c] The maximum possible value for each of the tabled means is 5.0.

[d] Means not computed because of lack of applicability to booklet.

[e] Grand Mean: N = 149 evaluations; S.D. = 0.43; and Rel. = 0.81.

about the nature of the variables underlying the differences and similarities observed.

Analysis by Booklet

The results of this analysis are summarized in Table 3. At the outset, however, some terminology should be clarified. Four types of means are depicted in the table. The first type is called an individual item mean. These means make up the bulk of the table. There is one of these means for each question for each booklet. (For example, the individual item mean for Question 1 for *It Sure Doesn't Taste Like School* is 4.91; the individual item mean for Question 8 for *Electricity and Reasoning* is 4.06.) There are also booklet means and item means. A booklet mean is the mean of all the weighted individual item means for a given booklet. (For example, the booklet mean for *Cheap But Interesting* is 4.33.) An item mean is the mean of all weighted individual item means for all booklets for a given item. (For example, the item mean for Question 4 is 4.44.) Finally, there is a grand mean (4.37), which can be considered either the mean of the weighted item means, or the mean of the weighted booklet means. In essence, it represents the mean response to all items for all booklets.

The grand mean of 4.37 represents a response which falls between "usually" and "yes or almost always" on the 5-point scale. This constitutes a highly favorable overall evaluation of Project' materials. The split-half reliability for all booklets is 0.81. An insight into the nature of booklet attributes may be gained by examining those components which have contributed to this overall positive assessment. A number of interpretations are suggested by referring specifically to the booklet and item means.[2]

First, it will be noted from Table 3 that the two highest booklet means are those associated with *It Sure Doesn't Taste Like School* and *An Introduction to Linear Measurement with the Metric System* (both 4.56). Neither of these high means is particularly surprising, and this result is generally quite consistent with the open-ended TRF comments and with oral feedback obtained through teacher interviews.

The two lowest booklet means were 4.18 for *Up, Up, and Away* and 4.16 for *Electricity and Reasoning*. (Note: 4.16 is certainly not low within the framework of the 5-point continuum. Any mean above 4.0 should be no cause for concern. However, it was felt that further insight into Project booklets might be gained by considering mean responses which were relatively low, i.e., low relative to other mean responses.) The 4.18 booklet mean for *Up, Up, and Away* is not particularly surprising. The booklet's style is unorthodox, the philosophy quite non-directive. In the open-ended comments, most concern was expressed regarding the omission of explicit directions for the construction of kites. On the other hand, the 4.16 for *Electricity and Reasoning* is puzzling at first. However, on reflection, it is clear that this booklet is by far the most technically difficult of all the Project booklets that were field-tested. The subject matter content was probably unfamiliar to many of the trial teachers so that successful implementation required a good deal of teacher preparation. It is hypothesized that these circumstances colored teachers' reactions toward the booklet so that in some areas it was evaluated "downward."

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[2] Again, it should be stressed that the discussion to follow should be considered an informal speculation about the data collected. No statistical tests were performed and, for this reason, no inferences to the general population of teachers are warranted.

Booklet standard deviations range from a high of 0.88 for *Line Symmetries of Polygons* to a low of 0.26 for *It Sure Doesn't Taste Like School* and *Do You See What I See?* In fact, with the exception of *Line Symmetries of Polygons*, all standard deviations are 0.43 or lower, which represents less than half a point on the 5-point scale. For some reason, teacher-evaluators were much more divergent in their opinions of *Line Symmetries of Polygons* than of any other booklet.

With respect to the item means, the range is from a high of 4.59 for Question 7 to a low of 4.15 for Question 3. Here again it should be noted that all item means are above 4.00, and that "low" means are low only in a relative sense.

Standard deviations associated with the item means are consistently greater than those associated with the booklet means. The range is from a high of 0.92 for Question 9 to a low of 0.60 for Question 7.

Conclusions

Looking at the categories of items included on the TRF, it is evident that the booklets were evaluated higher on questions related to mechanics than on questions of substantive import or subject matter integration. However, it may be that the former types of questions were merely easier to evaluate in a relatively short period of time (i.e., two to three months).

On the whole, the Project staff was pleased with the results of both the open-ended questions and the rating scale analysis. Means consistently above 4.00 represent highly favorable responses for all booklets and all items. Of course, this may be due largely to the characteristics of those teachers who evaluated our booklets. Teachers who volunteer to evaluate educational materials are not likely to be representative of all elementary school teachers. They are usually quite receptive to educational innovation. Witness, also, the fact that two-thirds of the TRF evaluations were completed by teachers who had rated themselves "informal" in their classroom style. The favorable response, then, is not surprising. In fact, it might have been far more surprising to find a number of mean responses lower than 4.00.

ANALYSIS OF RESPONSES:
TEACHER QUESTIONNAIRE

Introduction

In the analysis that follows, only one difference of statistical significance was detected. Even so, this difference was difficult to interpret because of the diversity of the sample involved. Normally, this type of situation would preclude any detailed discussion of experimental results. However, since this phase of the Project evaluation program was an exploratory one, and since we hope that others will pick up where we have left off, we will speculate "beyond our data" and note several trends suggested by the information collected. We are well aware of the extremely tentative nature of many of the ideas indicated below, but we hope that the discussion will be of value to those who are interested in this area of evaluation research and development.

There are a number of terms that should be understood before examining the statistical results. Data was collected for both a "19" and a "16" sample. The numbers refer to the number of items answered on the nineteen-item TQ. Teachers who only taught mathematics and/or science (i.e., departmental specialists) were instructed to omit the first three items of the questionnaire. (These items were appropriate only for teachers of self-contained classrooms.) Such teachers plus self-contained classroom teachers constituted the "16" sample, whereas only self-contained classroom teachers made up the "19" sample.

Because all teachers responded to the last 16 items, the N of the "16" sample is larger than the N of the "19" sample. When the overall results for the two samples were examined, they did not differ markedly and, since the "16" sample was larger and could be broken down into subgroups of N = 5 or greater, this group was selected for analysis. In considering the "16" sample, one point of possible confusion should be mentioned: The number of classrooms from which the data was gathered is smaller than the total number of responses used in the statistical analysis. This occurs because some teachers answered on the mathematics scale as well as on the science scale, and all responses on each scale were included in the analysis.

This sample was first divided into two sub-samples--the "Two Booklets 16," which consists of teachers who completed two Project booklets and the five associated rating indexes (TQ_1O, TQ_2O, TQ_2X, TQ_3O, and TQ_3X), and the "One Booklet Only 16," which consists of teachers who completed only one booklet and the three associated rating scales (TQ_1O, TQ_2O, and TQ_2X), then dropped out of the evaluation program for one reason or another.

The teachers who completed the various forms of the TQ were further categorized according to whether they responded to the same scales on all forms (i.e., mathematics and/or science on TQ_1, TQ_2, and TQ_3) or whether they responded to different scales on different forms (e.g., the mathematics scale on TQ_1, the science scale on TQ_2, and the mathematics scale on TQ_3). These subgroups are labeled "Mathematics" and "Science," and the latter group of teachers described "Conglomerate."

The Mathematics and Science subgroups are relatively homogeneous and consistent with respect to subject matter organization for instruction; the third one, the Conglomerate, is very diverse. It includes teachers who changed scales from one form to the next for various reasons, as well as teachers who responded to the mathematics/science scale on all forms. None of the individual components of this subgroup was large enough to be amenable to statistical analysis. Even though a statistically significant difference did emerge, the diversity of this subgroup makes it extremely difficult to draw meaningful conclusions.

For purposes of data processing, a value of "7" was coded to indicate the most informal response, a value of "1" the most formal, and so on.[3] Descriptive statistics for the various samples and sub-samples employed in the analysis are presented in Table 4.

Pre-Trial Teaching Versus While-Using-the-Booklet Teaching

In order to assess the influence of Project materials on teaching style, it is important first to ascertain the way teachers viewed their normal teaching before ever encountering any of

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[3] All statistical computations were performed using the SOUPAC (Statistically Oriented Users Programming and Consulting) set of statistical programs, developed at the University of Illinois at Urbana-Champaign under the direction of the late Dr. Kern Dickman. The manual used was the most recent, dated February 1, 1972.

TABLE 4

MEANS, STANDARD DEVIATIONS, AND RELIABILITIES OF TEACHER QUESTIONNAIRE SAMPLES

		Two Booklets 16			One Booklet Only 16		
		Mathematics N = 5	Science N = 13	Conglomerate N = 26	Mathematics N = 20	Science N = 22	Conglomerate N = 20
TQ_1O	Mean[a]	4.70	5.25	5.05	4.72	5.46	5.24
	S.D.	0.93	0.73	0.98	0.72	0.55	0.83
	Rel.[b]	0.83	0.92	0.93	0.87	0.66	0.87
TQ_2O	Mean	4.54	5.42	4.93	4.72	5.33	4.88
	S.D.	0.40	0.59	0.93	0.77	0.57	0.60
	Rel.	0.92	0.87	0.91	0.78	0.65	0.76
TQ_2X	Mean	5.08	5.35	5.32	4.99	5.34	5.14
	S.D.	0.63	0.52	0.79	0.69	0.60	0.66
	Rel.	0.95	0.28	0.89	0.74	0.58	0.63
TQ_3O	Mean	4.58	5.46	4.95			
	S.D.	0.67	0.58	1.13			
	Rel.	0.87	0.85	0.93			
TQ_3X	Mean	4.20	5.18	5.31			
	S.D.	1.02	0.99	0.88			
	Rel.	0.91	0.92	0.87			

[a] Mean of the 16 item means. The maximum possible value is 7.0 (7 = most informal). To obtain the mean for the entire questionnaire, multiply the tabled value by 16.

[b] Split-half reliability (odds versus evens), calculated from the Spearman-Brown prophecy formula

our booklets. On the seven-point rating scale, teachers of mathematics in the Two Booklets sample averaged a rating of 4.70 for their pre-trial self-description (TQ_1O), whereas teachers in the One Booklet Only sample averaged 4.72. Teachers of science in these samples rated themselves on the average as 5.25 and 5.46, respectively. This suggests that, prior to using Project booklets, teachers considered themselves more informal while teaching science than while teaching mathematics. It also serves as a warning that a possible "ceiling effect" may be in operation--that is, that teachers had less room to move toward the informal end of the scale in science than in mathematics when they filled in later scales.

With these facts in mind, it is not surprising, when considering the two major samples, that teachers of mathematics--while not becoming significantly more informal when using our materials--did exhibit a greater change in that direction than did teachers of science. On the TQ_2X ratings, the mathematics means were 5.08 and 4.99 for the Two Booklets and the One Booklet Only samples, respectively. The means for the corresponding science samples were 5.35 and 5.34. As has been mentioned above, teachers of mathematics may have had more room to move toward informality than did teachers of science. There is even some evidence that suggests a tendency for teachers of science in the One Booklet Only sample to use our materials more formally than their normal science materials as rated in TQ_1O. The TQ_1O mean for this group was 5.46, whereas the TQ_2X mean was 5.34.

After using their first (or only) booklet, teachers of science in both samples rated themselves at approximately the same position on the formal-informal scale (5.35 versus 5.34) *even though* the teachers in the Two Booklets sample were somewhat less informal (5.25 versus 5.46) prior to using our booklets. Perhaps our materials imply a certain type of learning environment for science teaching when they are being used, and this expectation provides another type of "ceiling" which is difficult to surpass regardless of the original level of informality.

This does not seem to be true for teachers of mathematics. Both major samples rated their informality at about the same level before attempting our booklets (4.70 versus 4.72). However, after completing the first booklet, those who later went on to a second booklet were slightly more informal (5.08) than those who dropped out at that point (4.99).

After finishing their second booklet, teachers of mathematics and science in the Two Booklets sample both rated themselves relatively more formal than after their teaching of the first booklet (5.08 versus 4.20 and 5.35 versus 5.18). Their second booklet ratings were also more formal than their normal classroom teaching before they ever used our booklets (4.70 versus 4.20 and 5.25 versus 5.18). None of these differences, however, were significant; nevertheless, there does not seem to be an easy explanation for this increasing formality with successive booklets. One possibility, though, is that teachers had no practical referent or standard for informality/formality prior to the teaching of their first booklet. However, as they worked with our materials, were presented with one or more informal instructional models, and compared their own style to these models, they came to consider themselves more "formal" than before.

Tests of significance for the various comparisons discussed above are displayed in Table 5 on the next page.

Pre-Trial Teaching Versus Normal Teaching at the Time Project Booklets Were Being Used

Teacher-evaluators were asked to describe their classrooms and teaching practices prior to receiving their first Project booklet (TQ_1O). After finishing each booklet, they were again asked to describe the appearance of their classrooms when Project materials were not being used (TQ_2O and TQ_3O). In order to assess the possible "spillover" effect of the Project on other topics and curriculum areas, this part of the analysis was devoted to comparing the data derived from these three administrations of the TQ.

Only one of the observed differences was found to be statistically significant (see Table 5). This is a highly significant difference ($.002>p>.001$) between the TQ_1O and TQ_2O means of the "One Booklet Only Conglomerate" group, in the direction of greater formality. A visual inspection of the remaining data also suggests a slight trend toward more formal teaching of mathematics and science at the same time our booklets were being used (but not during their actual use).

It is possible that this rather weak trend could have been

TABLE 5

TESTS OF SIGNIFICANCE BETWEEN SAMPLE MEANS ON TEACHER QUESTIONNAIRE

Comparison		Two Booklets 16			One Booklet Only 16		
		Mathematics df = 4[a]	Science df = 12	Conglomerate df = 25	Mathematics df = 19	Science df = 21	Conglomerate df = 19
TQ_1O/TQ_2O	t[b]	0.532*	1.338	1.028*	0.000	1.125*	3.775*
	p[c]	.80>p>.60	.40>p>.20	.40>p>.20	p>.80	.40>p>.20	.002>p>.001[d]
TQ_1O/TQ_3O	t	0.329*	1.272	0.885*			
	p	.80>p>.60	.40>p>.20	.40>p>.20			
TQ_2O/TQ_3O	t	0.210	0.318	0.122			
	p	p>.80	.80>p>.60	p>.80			
TQ_1O/TQ_2X	t	0.635	0.433	2.054	2.004	0.982*	0.714*
	p	.60>p>.40	.80>p>.60	.10>p>.05	.10>p>.05	.40>p>.20	.60>p>.40
TQ_1O/TQ_3X	t	1.035*	0.202*	1.662			
	p	.40>p>.20	p>.80	.20>p>.10			

[a] Sample size is very small, but statistics have been included for completeness. They should be interpreted with great caution.

[b] Values of t marked with an * reflect changes toward the formal direction; those without an * reflect changes toward the informal direction.

[c] Two-tailed test probabilities.

[d] Significant at the .05 level, or beyond.

caused by a "backlash" reaction to Project materials and/or to the TQ; however, it is more likely that such a trend, if it does exist, is related to the structure of the Teacher Questionnaire and its mode of self-administration.

When the first rating of normal classroom practice was made, each teacher used some standard or set of standards--unknown by us--against which to make this judgment. Certainly these standards varied considerably from teacher to teacher. When the second and third ratings of normal practice were made, teachers had a common standard, namely our booklets, against which to judge their teaching of mathematics and science. Teachers may have even rated their teaching while using our booklets first (TQ_2X and TQ_3X); and then, using this rating as a standard, rated their normal classroom teaching for that period (TQ_2O and TQ_3O). This assumption is plausible since it would probably be much easier to rate specific teaching when using our booklets than it would be to rate normal classroom teaching of mathematics and science when not using our booklets (even though the TQ instructions directed teachers to rate their teaching without the booklets first).

Since, as was previously mentioned, the TQ_1O ratings were relatively high--particularly for science--this made it all the more likely that the TQ_2O and TQ_3O responses would be equal to or lower than the TQ_1O responses. Such results would make it appear that there had been no change in normal teaching or that there had been an apparent movement toward more formal instruction. These figures, however, might not indicate so much that the teaching had become more formal as that the ratings themselves had become more formal because of the influence of a more explicit standard of informality.

In future research of this nature, the administration procedure should be modified: teachers should be required to return their ratings on normal classroom teaching before they are sent the questionnaire for assessing the way they taught when given experimental materials were being used.

The analysis above exceeds the scope originally planned by the Project staff. Even so, as the results unfolded, it became obvious that still additional comparisons and hypothesis-testing were very much in order. In particular, it was felt that analyses of individual questionnaire items were needed to better interpret the subgroup means of the various samples and subsamples. Furthermore, it was the opinion of Project staff that a more complete evaluation would have generated and examined a number of comparisons between the Mathematics, Science, and Conglomerate subgroups.

CONCLUSIONS

Two objectives were sought during the course of this evaluation program. The first was to assess the "teachability" and general quality of the curriculum materials developed. The second was to explore techniques for evaluating materials designed for use in open classroom settings. Considerable progress was made in working toward the first objective, while some noteworthy ground-breaking was achieved in working toward the second.

In general, the feedback gained through the Teacher Reaction Forms was very favorable. Both item (attribute) and booklet means were quite high. This data provides evidence that Project publications--in terms of readability, interest level, and usefulness--succeeded very well in hitting the mark. Responses to the open-ended questions supported the attribute ratings. In addition, more than 85% of the respondents indicated that they would use their booklet again; less than 4% replied that they would definitely not use their booklet again.

On the other hand, the analysis of the Teacher Questionnaire raised many more questions than it answered. Because of the size of some of the subgroups, it was frequently difficult to perform statistical tests without pooling or lumping data that reflected rather different instructional situations. The general lack of statistical significance in the comparisons that were made also required us to be content with searching for trends--many of which, although sufficiently conspicuous to be recognized, were certainly on the weak side. The need for additional comparisons was also realized as the various pieces of the total analysis began to fall into place.

The question of classroom tone and teaching style--specifically, informality versus non-informality--has barely been touched. Much more thorough and sophisticated research needs to be done to throw light on the relationship between these characteristics and learning outcomes. We do have the suspicion that these styles of teaching are relatively stable and that it is extremely difficult to detect any change whatsoever over as short a period of time as six or seven months.

Thus, the Project must consider the analysis of the Teacher Questionnaire data to constitute only a beginning. Much remains to be done.

With respect to developing techniques for assessing the effectiveness of curriculum materials in open classrooms, the TQ deserves further attention. The instrument has produced some interesting data and, with appropriate modification to facilitate ease of response, might be generally useful for describing classrooms and detecting changes in methodological orientation.

Work on observation and interview techniques was by-passed because of the lack of sufficient Project resources. It is felt, however, that the items on the Teacher Questionnaire might constitute a good starting point for the development of such techniques.

* * *

To close this part of the Final Report, a general comment on the evaluation of curriculum development projects is in order. Although some thought must be given to evaluation from the very beginning of such a project, specific techniques must wait upon the evolution and maturation of project objectives and procedures. Sometimes this process requires years. At the same time, it is realized that a curriculum project must have feedback on which to base the ongoing development of its materials. Often, much of this feedback must come from trial centers at great distances from project headquarters and so must be gathered by means of a formal evaluation instrument of some kind. The profession also needs to be informed of promising educational innovations--with a minimum of time lag.

As a case in point, the Project on Elementary School Mathematics and Science found itself in a similar type of dilemma. On the one hand, during the fourth year of the Project many of our objectives were still too general to be easily evaluated. (As a matter of fact, the development of this report was of great assistance in helping the staff to focus on the essence of what we had been striving to accomplish.) Furthermore, with only first editions of our booklets to be tried out in the year ahead, we certainly did not feel that we were ready for a "final evaluation" of our curriculum development efforts.

On the other hand, though, because we knew that the term of the Project was drawing to a close, we felt that a variety of data was needed to describe the success of our efforts to the

National Science Foundation. Extensive feedback from teacher-evaluators would also be likely to be of benefit if our materials were ever readied for commercial publication. Finally, we sensed a commitment to communicate our experiences to the profession at large--and the fifth year of the Project was going to be our only opportunity to develop the base for doing so.

Therefore, the techniques devised by PESMS to evaluate its work constituted a compromise between a reasoned reluctance to plunge prematurely into a full-scale evaluation program and the need to obtain formative and summative feedback and to inform the profession of our achievements and failures. These techniques should be considered tentative and subject to revision, but we hope that other projects will find something of practical value in what we have done and will carry on from where we have left off.

PART IV

ASSESSMENT OF PROJECT ACCOMPLISHMENTS

CURRICULUM DEVELOPMENT EFFORTS

By what standards can the efforts of a curriculum development project be judged? This was an important first question to which the Project staff addressed itself as it attempted to evaluate its work of the preceding four and a half years.

The criteria below were generated by the staff as a means for examining only the curriculum development aspects of the Project. Later in this part of the Final Report, there will be a brief discussion of other concerns on which the Project focused in its first years.

Success Criteria for a National Curriculum Development Project

1. The materials produced by the project should reflect the best of current thinking in the subject matter areas investigated: The work should be premised on current research and modern trends in education; it should be designed to accommodate the schools of today and tomorrow, not those of yesterday.

2. The materials produced by the project should address a pressing educational need: The work should be addressed to an existing need in the educational system; it should not be addressed to needs which have already been met or to problems which might arise in the distant future, although needs of the near future should indeed be viewed as a legitimate focus for a project's activities.

3. The materials produced by the project should embody the philosophy and goals of the project: The work of the project should be congruent with the goals it has set for itself; it should reflect the common educational point of view that the project has adopted.

4. The materials produced by the project should clearly communicate ideas to professionals at the classroom level: The

materials should be written so that classroom teachers can easily read and comprehend them; the materials should not be written in the same "dry" manner as technical journals frequently are. The materials should, in addition, be presented in such a style that they are enjoyable as well as informative.

5. The materials produced by the project should be capable of being used with success in a variety of classrooms: Since many teaching styles and circumstances are to be found in any community, the materials should have proven themselves successful in a wide variety of educational contexts. They should be designed for wide use rather than narrowly addressed to a very small segment of the profession.

6. The materials produced by the project should be broadly disseminated and widely utilized: No single city or state should be the "proving ground" for materials produced by a national curriculum development project. The materials should have received national exposure, not just regional recognition.

7. The materials produced by the project should be significantly different from materials produced by other projects or groups: The work of the project should constitute a unique contribution to the field of education, not a duplication or rehashing of the work of others.

8. The materials produced by the project should serve to encourage classroom teachers to attempt similar innovations: The philosophy of the materials should be evident so that readers will not only use the materials, but will also apply the philosophical bases to the teaching of other topics.

With such criteria in mind, the Project staff assessed its accomplishments. In summary form, these assessments are presented below.

Assessment of Accomplishments

1. Materials Should Reflect the Best of Current Thinking

Contributing significantly to the efforts of the Project were visits made by staff to several national curriculum development projects in this country and abroad and to primary schools in England. These visits gave the Project an idea not only of current thinking with respect to mathematics and science education, but also of the directions future trends in these areas might take. In addition, on numerous occasions, visiting consultants of national and international reputation worked closely with the Project in its efforts. These consultants were able to provide insights not only into the content of new curriculum materials but also into some of the most effective techniques for developing curriculums.

The Resource Center at the Washington School contained a large number of publications relating to new curriculums, and the library in the teachers' lounge provided hundreds of books relating to open education and to mathematics and science teaching. All of these sources helped the Project and teaching staff at Washington School keep abreast of, and develop materials in the light of, current trends in mathematics, science, and education.

2. Materials Should Address a Pressing Educational Need

It seems safe to predict that within the next decade the movement toward informal education will increase rather than decrease. Teacher training institutions today are devoting more classroom discussion to this topic than was the case five or ten years ago. As a result, teachers entering the profession will be more inclined to explore informal approaches to education than in the past. In short, more teachers with an interest in open education are now, and will be, teaching in the United States than previously. Thus the need for appropriate materials, beginning to be perceived now, will certainly increase in the near future.

We feel that the Project's materials do fill a definite need--both current and future. Our booklets provide interesting, practically-oriented, manipulatively-based materials for use in conventional elementary schools. They also lend themselves to use in open classrooms since they (a) are activity-oriented, (b) are premised on individually-paced instruction, (c) integrate mathematics and science in situations which are mutually reinforcing, and (d) integrate most of the traditional subject areas of the curriculum.

3. Materials Should Embody the Philosophy and the Goals of the Project

Not all of the booklets produced by the Project place a strong emphasis on the integration of several subject areas. In particular, *An Approach to Symbolic Representation*, *Line Symmetries of Polygons*, *Electricity and Reasoning*, and *An Introduction to Linear Measurement with the Metric System* do not attempt to explore the many possibilities for subject matter integration. However, all the booklets produced do readily lend themselves to individually-paced instruction and are manipulatively- and activity-based.

4. Materials Should Clearly Communicate Ideas to Professionals at the Classroom Level

Analyses of the Teacher Reaction Form data make it apparent that one of the strongest facets of Project booklets has been their readability and clarity of expression. Since these reactions were provided by elementary classroom teachers, it does appear that PESMS has met this criterion.

5. Materials Should Be Capable of Being Used with Success In a Variety of Classrooms

In examining the TRF data, a small difference was found between the responses of teachers in the "Informal" and "Non-Informal" categories. The mean of the individual item means for informal teacher-evaluators was 4.41; for non-informal evaluators, 4.29. A determination was not made, however, as to whether this 0.12 of a point difference was statistically significant. (Informal N = 99; Non-Informal N = 50.) Therefore, without further analysis, it cannot be stated that our materials were any more successful in informal classrooms than in non-informal classrooms.

It needs to be pointed out, however, that for both groups--Informal and Non-Informal--the materials were rated quite highly (4.41 and 4.29 on a 5.00 scale). What can probably be safely concluded is that Project materials were used successfully in both informal and non-informal settings.

6. Materials Should Be Broadly Disseminated and Widely Utilized

Completed evaluations were received from teachers in 16 states. There were, however, two major geographic areas of concentration--the state of Illinois and the Northeast. Of the 104 teacher-evaluators included in the analyses, roughly 70% were located in these two areas. Therefore, the participants in the evaluation program were not as geographically representative as the Project would have wished.

Project materials were, however, purchased by educators across the country; and displays of our booklets were set up at National Science Teachers Association conventions and conferences in New York, Detroit, San Diego, and St. Louis. Some national exposure was gained in this way, and we do feel that people from all parts of the country did have an opportunity to become aware of our efforts.

7. Materials Should Be Significantly Different from Materials Produced by Other Projects or Groups

Because of their interdisciplinary and informally-oriented design, it is felt that Project materials do indeed represent an effort which is significantly different from that of other national projects. To the best of our knowledge, no other group has attempted such a large-scale program for developing multidisciplinary materials specifically for open classroom settings. (The efforts of USMES--the Unified Science and Mathematics for Elementary Schools project--seem to lie closer to ours, by far, than those of any other curriculum development project.)

8. Materials Should Encourage Classroom Teachers to Attempt Similar Innovations

The responses given to the open-ended questions on the Teacher Reaction Form indicate that teachers using Project materials frequently did embellish the activities suggested with ideas of their own. (We have no data, however, to indicate that the teacher-evaluators attempted similar innovations when they were not using our materials.) Analyses of the Teacher Questionnaires, though, do not provide any statistical evidence to support the contention that teachers became any more informal in their approach to the teaching of mathematics and/or science. Thus, it appears that while Project materials may encourage teachers to be more innovative in their approaches, they do not exert a measurable influence on their teaching style.

OTHER EFFORTS

Aside from curriculum development work, the Project also directed its attention to other areas of endeavor during its five years of existence. Work began in 1968 with an attempt solely to examine strategies for teaching mathematics and science together, then shifted to an emphasis on the methods by which informal approaches might be implemented in American schools. From this point the focus broadened to include the in-service training of teachers--assisting American teachers to integrate different subject areas for use in more informally organized classrooms. The final shift occurred when it was decided to produce curriculum guidebooks integrating mathematics, science, and other curriculum areas for use in informal settings.

Since these other efforts of the Project were not pursued as vigorously as the development of curriculum materials, they will not be examined in detail in the present report. However, a general assessment of the work in these areas will be made in the following section.

PROJECT ACHIEVEMENTS AND DISAPPOINTMENTS

The preceding discussion systematically delineated the Project's assessment of its curriculum development efforts. However, it was intentionally limited in its scope and did not attempt to communicate an overall picture of the major achievements and disappointments in the Project's five-year history. The following paragraphs are intended to highlight what the staff feels are those important "hits" and "misses."

Achievements

We feel that PESMS succeeded in its goal of re-thinking the nature and form of mathematics and science activities at the elementary school level. We are convinced that we have developed educationally sound ideas for correlating the study of mathematics and science with each other and with the entire elementary curriculum.

Alternative classroom formats were also successfully investigated by the Project. Along with our attempt to examine and describe more practicable designs for classroom organization, we also evolved an instrument (the Teacher Questionnaire) which might, with refinement, provide a basis for the analysis of informal teaching behaviors.

The Project staff believes that we have generated some interesting ideas and materials for use in both informal and non-informal classrooms. The responses received on the Teacher

Reaction Form provide support for this belief. Our materials also appear to have been successful in effectively communicating with elementary classroom teachers.

The Project on Elementary School Mathematics and Science succeeded in obtaining some national exposure through the display of our materials at several national conventions and regional conferences. We feel that our work has had some impact nationally upon the profession. This is quite gratifying when it is remembered that most of our materials were available for distribution only during the final year and a half of the Project. Had these booklets been disseminated over a longer period of time, their impact would certainly have been greater.

We believe that our work has directly benefited the Washington School and the teaching staff of the Champaign Community Schools. Teachers at Washington School worked in an atmosphere which encouraged experimentation and innovation. Many classroom ideas were then passed along by these teachers to other local teachers via workshops and curriculum materials. In addition, Project staff members conducted a number of workshops for local educators. We believe that through these and similar efforts we have helped to upgrade educational programs throughout our community.

Disappointments

Although the Project takes pride in these achievements, there were also several disappointments. One such disappointment was our inability, due to lack of time, to do justice to several promising avenues of curriculum development work. As an example, we would have liked to have explored further the potentialities and limits of teacher-written curriculum materials. As it was, we were able to conduct only two summer writing conferences, those being in 1971 and 1972. We would have preferred to have organized more such conferences--especially for teachers who were not employed at Washington School--in an attempt to determine if curriculum writing might be more effectively implemented by practitioners than by subject matter specialists.

We were also disappointed that we were unable to edit, print, and distribute all of the materials produced by the Project. Thirteen manuscripts were developed but not published: three written by teachers, ten by Project staff.

Furthermore, we did not reach the goal of combining mathematics, science, and informal pedagogy into all publications. Perhaps this was an unrealistic goal considering the great diversity of interests, philosophies, and strengths possessed by any group of curriculum developers. Nevertheless, this was one of our goals and we failed to reach it to the extent that we had hoped.

The staff also felt that more time was needed to obtain a broader spectrum of feedback on the use and effectiveness of Project materials. The brevity of the trial period placed limits on the number of teachers we were able to enlist to try out each of our nine preliminary editions. Additionally, the lack of time and manpower made it extremely difficult to implement our original plans to observe many trial classes in action and to interview a large number of teachers, children, administrators, and parents.

The Project staff would have especially liked to have had much more personal contact with teacher-evaluators. In the form of either informal talks or classroom observations, this contact could have contributed much to assessing the impact of our materials--not only in teaching concepts and skills but also in influencing teaching styles.

Because of termination of the development phase of the Project, we did not have an opportunity to revise our materials in terms of the feedback we did receive. Although, as indicated, this feedback was not as extensive as we would have liked, we wish that we would have had time to examine our booklets in the light of this information and incorporate needed revisions into a set of second editions.

Our final disappointment concerns the degree of impact the Project has had on Washington School teachers and other Champaign school personnel. We are highly skeptical that teachers after leaving Washington School are as innovative as they were while teaching within the context of Project activities. In addition, we doubt that they have had much of an effect on changing the teaching materials and styles of their colleagues in their new schools. In short, even though the Project believes that it has made a contribution to improving the local school system, it does not feel that the improvement has been as great as it might or should have been.

CONCLUDING COMMENT

This Final Report ends on a note sounded by many researchers upon completion of a major project: We have accomplished much, we are proud of our efforts, but more needs to be done. We have provided answers to some questions, but we have raised many more. We are hopeful that someone else will wish to continue the work we have started, answer the questions we have raised, and raise still more questions for future researchers to answer. It is only through such a process of seeking and finding solutions to existing problems and identifying components of new ones that we can assure the continual improvement of the process and substance of education.

APPENDIXES

APPENDIX A

Project Staff

PROJECT STAFF

Symbols representing years in which
staff member participated in Project:

I = 1968-69; II = 1969-70; III = 1970-71; IV = 1971-72; V = 1972-73.

Artists

Jay Boydstun (Undergraduate Assistant)	V
Mary Jain (Undergraduate Assistant)	Summer 1972
Todd Trieloff (Undergraduate Assistant)	V

Consultants

Edith E. Biggs (Mathematics Educator, England)	I, II, III, Summer 1971
F. Frank Blackwell (Science Educator, England)	II
Theodore Manolakes (Elementary Education, Professor, University of Illinois)	I, II, III, IV
Marianne Parry (Early Childhood, England)	II
Frieda S. Ployer (Science and Mathematics Educator, United States)	II, Summer 1971
William R. Powell (Reading, Professor, University of Illinois)	IV
Elwyn S. Richardson (Creative and Language Arts, New Zealand)	III
Charles M. Weller (Science Educator, Assistant Professor, University of Illinois)	I

Note: This listing includes all of the University-related staff to work under the auspices of the Washington School Project. Personnel designated with an * were considered to be "regular" members of the staff of the Project on Elementary School Mathematics and Science, although all were not paid out of NSF funds.

Dora E. Whittaker (Mathematics Educator, England)	II, Summer 1971
Robert W. Wirtz (Mathematics Educator, United States)	I

Design Laboratory

David Atkin (High School Student Assistant)	I, Summer 1971
Alison Barr (High School Student Assistant)	III
*Gregory S. Bell (Graduate Assistant)	III, IV, V
Charles Crnkovich (Graduate Assistant)	III, Summer 1971
*Charles N. Douglas Jr. (Illustrator)	I, II, III, IV
*Charles O. Prickett (Graduate Assistant)	II, III
*Norbert J. Salz (Assistant Specialist)	II, III, IV, V
Laurie Weller (Non-academic Assistant)	III

Early Childhood

Susan M. Bliss (Graduate Assistant)	II
Kathryn M. Collins-Thompson (Graduate Assistant)	III
Sydney Dickson (Graduate Assistant)	II
Patricia J. Eggleston (Graduate Assistant)	III
Richard S. Hirabayashi (Graduate Assistant)	III
Eunice V. Johnson (Graduate Assistant)	III
Dorothy McCall (Graduate Assistant)	III
Jane S. Morpurgo (Graduate Assistant)	III
Margaret A. Rice (Graduate Assistant)	II, III
Bernard Spodek (Early Childhood, Professor)	I, II, III, IV
Veronica Wood (Graduate Assistant)	II

Editor

*Ronald V. Jones (Assistant Specialist)	III, IV, V

Floating Teacher

*Jane M. Gilchrist (Assistant Specialist)	IV, Summer 1972

Mathematics Education

*David C. Barr (Graduate Assistant)	V
*Max Beberman (Professor; PESMS Director I, II, III; deceased)	I, II, III
Peter G. Braunfeld (Mathematics and Education, Professor)	I, II
Barbara A. Francis (Graduate Assistant)	Summer 1971
Joella H. Gipson (Specialist)	II, III
Jonathan E. Knaupp (Graduate Assistant)	II
*Sister Louise M. Lutz (Graduate Assistant)	III, IV
*Sylvia J. Pattison (Specialist)	II, III, IV
Jo M. Phillips (Senior Specialist)	I
*T. Thacher Robinson (Specialist)	I, II, III, IV
Andrea M. Rothbart (Mathematics, Instructor)	I, II
*Harold A. Taylor (Assistant Specialist, Director of Resource Center)	III, IV

Miscellaneous

Susan Applegate (Graduate Student Volunteer)	IV
J. Myron Atkin (Science Educator; Dean, College of Education; Professor)	I
Harold W. Bradley Jr. (Specialist)	III
Donald Day (High School Student Assistant)	I
*Kurt P. Froehlich (Graduate Assistant)	IV, V

William M. Golden (Research Associate)	I
Leeta Martha Hamilton (Graduate Assistant)	III
Edwin C. McClintock Jr. (General Engineering, Professor)	II, III, IV
Walter J. Moore (University Liaison; Elementary Education, Professor)	I
Jeannine Mosely (Undergraduate Assistant)	III
Stephen Osborn (Undergraduate Assistant)	III
Joyce Riley (Graduate Assistant)	III
Charles W. Rusch (Architecture, Visiting Assistant Professor)	II
Judith E. Sandelin (Graduate Assistant)	II
Baharin Shamsuddin (Visiting NSF Fellow)	Summer 1971
Zola Sullivan (Graduate Assistant)	I
Doris White (Graduate Assistant)	III

PLATO

Richard A. Avner (Research Associate)	III
Jane Durbin (Undergraduate Assistant)	III
Esther R. Steinberg (Assistant Specialist)	I, II, III, IV, V
Herbert Zweig (Graduate Assistant)	III

Science Education

*Donald O. Crowe (Graduate Assistant)	III
Jerome E. DeBruin (Graduate Assistant)	II, Summer 1971
*Richard W. Griffiths (Visiting Assistant Professor)	IV, V
*Gary W. Knamiller (Graduate Assistant)	II, III
*Peter B. Shoresman (Professor; PESMS Director III, IV, V)	I, II, III, IV, V

*Carla S. Vossler (Graduate Assistant)	III, IV
Claire M. Walker (Specialist)	III, Summer 1971

Secretaries

*Margaret H. Brengle	IV, V
Luella M. Busboom	V
*Vickie J. Dutton	III
*VaLera P. Leemon	II
*Mary E. Phillips (Clerk of Resource Center)	III, IV
*Lucretia F. Shulman (deceased)	I
*Elizabeth Swenson	I, II

APPENDIX B

Miscellaneous Material Related to the Process of Selecting a Commercial Publisher

PROJECT ON ELEMENTARY SCHOOL MATHEMATICS AND SCIENCE
DIRECTOR: PETER B. SHORESMAN, COLLEGE OF EDUCATION

UNIVERSITY OF ILLINOIS
at Urbana-Champaign

Affiliated with:
University of Illinois
Curriculum Laboratory
Washington School Project

Booker T. Washington School
606 East Grove Street
Champaign, Illinois 61820
Telephone: 217-333-1906

February 1973

ANNOUNCEMENT OF PUBLICATION PLANS

The Project on Elementary School Mathematics and Science, which has been supported since 1969 by the National Science Foundation, has produced a collection of teacher guidebooks focusing on the correlation of mathematics and science. These booklets are designed for use in open classroom settings and are suitable for children in grades kindergarten through nine. So far, this development work has been experimental. Materials were initially developed in an experimental public school and have been tried out in selected classrooms across the country. Teacher reactions are presently being gathered for the purpose of determining the effectiveness of the materials.

Project materials do not reflect a mathematics or science sequence, but rather constitute a number of independent, self-contained sources of ideas which cover a wide variety of topics.

The University now intends to take steps to make the booklets generally available to educators. Therefore, we are soliciting indications of interest from commercial publishers about an "exclusive" publication agreement.

Among other stipulations, we are requesting that the following clauses be included in the agreement:

> "It is agreed that the work shall be published with a correct notice of copyright, with the following statement to be printed and enclosed with the copyright notice in a printed box:
>
>> Except for the rights to material reserved by others, the Publisher and the copyright owner hereby grant permission to domestic persons of the United States and Canada for use of this work in whole or in part without charge in the English language worldwide after (5 years from copyright date) provided that written

A COURSE CONTENT IMPROVEMENT PROJECT SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION

> notice is made to the Project on Elementary School Mathematics and Science and that publications incorporating materials covered by these copyrights contain the original copyright notice, and a statement that the publication is not endorsed by the National Science Foundation or by the original copyright owner. For conditions of use and permission to use materials contained herein for foreign publications in other than the English language apply to the Project on Elementary School Mathematics and Science."

"The Government may use, reproduce, or have reproduced or used for Government purposes the materials published under the agreement."

"The University of Illinois reserves subsidiary rights, including translations into foreign languages, during the period of exclusive agreement."

In addition, a cautionary statement is to appear in each booklet and in advertising materials indicating that the works have been used experimentally, and that teachers with average preparation will find that some of the booklets may initially require extensive preparation time.

Companies interested in the possibility of publishing Project materials should so indicate by 16 March 1973 to:

Mr. Ronald V. Jones
Project on Elementary School
Mathematics and Science
Booker T. Washington School
606 East Grove Street
Champaign, Illinois 61820

Copies of all the books produced so far will then be sent to interested parties and discussion will be initiated regarding further specifications.

The draft agreement negotiated by the contracting parties must be approved by the National Science Foundation before it is signed.

PUBLISHERS EXPRESSING AN INTEREST IN EXAMINING THE MATERIALS PRODUCED BY THE PROJECT ON ELEMENTARY SCHOOL MATHEMATICS AND SCIENCE

Addison-Wesley Publishing Company

Agathon Press, Inc.

Benefic Press

Creative Publications

Encyclopaedia Britannica Educational Corporation

General Learning Corporation

Harper & Row, Publishers, Inc.

Hawthorn Books, Inc.

Houghton Mifflin Company

Lyons and Carnahan/Educational Division/Meredith Corporation

Pawnee Publishing Company, Inc.

Random House, Inc.

Teachers College Press

COMPANIES REPRESENTED AT PUBLISHERS MEETING

13 April 1973

Harper & Row, Publishers, Inc.
2500 Crawford Avenue
Evanston, Illinois 60201

Attending Representative: Mr. Marshall L. Weissend

Houghton Mifflin Company
110 Tremont Street
Boston, Massachusetts 02107

Attending Representative: Mr. Albert W. Kingston

Lyons and Carnahan Educational Publishers
407 East 25th Street
Chicago, Illinois 60616

Attending Representatives: Mr. Charles H. Josephson
Ms. Zeta Rahbar

Pawnee Publishing Company, Inc.
P. O. Box 3435
Boulder, Colorado 80303

Attending Representative: Mr. Roland Gansman

Teachers College Press
Teachers College
Columbia University
1234 Amsterdam Avenue
New York, New York 10027

Attending Representative: Mr. Hanns L. Speer

PROJECT ON ELEMENTARY SCHOOL MATHEMATICS AND SCIENCE
University of Illinois
Booker T. Washington School
606 East Grove Street
Champaign, Illinois 61820

AGENDA

Meeting with Publishers

Room 3, Washington School
Friday, 13 April 1973, 9 a.m.

I. Introductions

II. History and philosophy of Project

III. Description of Project materials
  - A. Presentation by teacher-developers
  - B. Presentation by University staff

IV. Evaluation program
  - A. Description of trial centers and trial classes
  - B. Summary of feedback to date

V. Assessment of market potential

VI. National Science Foundation publication policies and requirements

VII. University of Illinois publication requirements

VIII. Project publication preferences
  - A. Specifications for books
  - B. Editing and revisions
  - C. Promotional considerations

IX. General discussion

PROJECT ON ELEMENTARY SCHOOL MATHEMATICS AND SCIENCE
Booker T. Washington School
606 East Grove Street
Champaign, Illinois 61820

PROJECT PUBLICATION PREFERENCES

I. Specifications for booklets.
  A. We desire that all booklets be published. This will be a major consideration in the selection of a commercial publisher.
  B. The contract must stipulate, by name, which of the booklets will be printed. Rights for only those booklets to be printed will be assigned to the company.
  C. The commercial versions of Project materials should be of a physical quality at least equivalent to the preliminary editions. Our prime concern is the wide dissemination of Project ideas to the educational community. It is not of great importance to the Project staff that the booklets appear in a "highly polished" form.
  D. The eleven booklets on the one hand and the *Sampler* on the other are to be considered separately. That is, the publisher does not have to print all of the sections in the *Sampler*, but should specify which ones it does wish to print. In addition, we would consider the possibility of printing some sections of the *Sampler* as separate booklets.
  E. We are opposed to the concept of our materials being produced as "kits" or "packages" as this is antithetical to the Project's philosophy that considerable educational benefit accrues from the improvisation, construction, and refinement of learning materials.
  F. We can provide the original line drawings and photographs appearing in the booklets produced to date. If a publisher wishes to add, or in some fashion modify these, it must bear the cost, not the Project, or the charges might be applied against royalty payments.
  G. A "cautionary statement" should appear in a prominent place at the front of each publication, advising that teachers using the booklets for the first time may find it necessary to devote more than an average amount of time and effort to prepare themselves for using the materials in the classroom.

H. The credits (authors and staff lists) as they now appear at the beginning of each booklet must also appear in the published versions.
I. There should be a clause in the contract stipulating how long after receipt of a finished manuscript from us the published version will appear.
J. The Project wishes to receive complimentary copies of each edition of each booklet.(The Project guarantees that these booklets will not be sold.)
K. In lieu of a portion of the royalties, the Project may be willing to accept from the publisher services such as the conducting of in-service workshops, the providing of consultant assistance, etc.

II. Editing and revisions.
A. The Project will appoint an individual (tentatively, the present Director) to serve as liaison between the Project and the publishing house. All communications regarding Project materials will be directed to, and coordinated by, this individual.
B. If the publisher decides that modifications or additions to the booklets are required, it should submit to the Project guidelines for such changes. At the discretion of the Project liaison person, such changes may be made himself or passed along for completion to the author of the work in question.
C. In submitting a contract to the Project, the publisher should also indicate which of those booklets or items in the *Sampler* it foresees being printed with no major substantive changes and for which items it foresees the necessity of major substantive changes.
D. The author of a booklet may stipulate that his name not appear as the author of the work. If such is the case, the authorship of the booklet will be credited to the "Project on Elementary School Mathematics and Science."
E. If, in the opinion of the Project liaison person, specified modifications cannot be accomplished by either himself or the author of the work within a reasonable period of time, he will so advise the publishing house and authorize them to make the modifications. Such modifications are still to be subject to his approval.
F. If either the Project liaison person or the author of the booklet is willing to make the modifications, they shall be paid a fee to be negotiated with the publishing house. Any fees the company might pay to other consultants for such work will be paid for by the company or charged against royalties.
G. If the company wishes, the Project will submit to it all evaluation data gathered on the booklets. The cost of the reproduction of this data will be borne by the publishing house or charged against royalties.

III. Promotional considerations.
   A. The Project, through its liaison person, shall be consulted about all advertising and promotion of its materials.
   B. The Project does not wish to have the right to approve all such advertising and promotion but does wish to have the opportunity to advise the publisher regarding the appropriateness and accuracy of such.
   C. If the name of the University of Illinois is to be used in promotion or advertising, prior written approval must be obtained from the University.
   D. In the advertising and marketing of its materials, the Project strongly requests that the publisher expend effort at least equivalent to that involved in promoting similar materials..

IV. Contracts and other bid materials should be submitted to the Project no later than 15 May 1973.

APPENDIX C

Data Collection Instruments Used in Evaluation Program

If you are interested in serving as a teacher-evaluator of our curriculum materials, please complete and return this form to:

Project on Elementary School Mathematics and Science
Booker T. Washington School
606 East Grove Street
Champaign, Illinois 61820

I would like to volunteer to use the booklet(s) indicated and will complete and return an evaluation form (3-4 pages) for each to the Project on Elementary School Mathematics and Science by February 1, 1973. I understand that the booklet(s) will be supplied to me free of charge in exchange for my written evaluation. I will supply any other materials needed to teach the unit(s).

Teacher's Name ______________________________
(please print plainly)

School Name and Address ______________________________

____

____

I would like to try _____ (1 or 2) of the following booklets. (Please list four in order of your preference. We will make every effort to fulfill your request.)

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

* * * *

We would like to have some basic information about the setting in which you will use our materials and would appreciate your answers to the following questions:

1. Number of students in school __________ 2. Average class size __________

3. Grade level(s) you teach __________ 4. Age range __________

5. Check all items that apply to your school setting:

______ Rural ______ Suburban ______ Small town (up to 20,000)

______ Small city (20,000-100,000) ______ Big city (more than 100,000)

______ Public ______ Private (describe briefly below)

6. Check all of the following items that apply to your class:

______ Heterogeneously grouped

______ Homogeneously grouped

______ Self-contained

______ Departmentalized

______ Informal

______ Team teaching

______ Other (specify)

7. Which of the following areas do you utilize regularly in your teaching?

______ Halls

______ Kitchen

______ Auditorium

______ Resource center

______ Playground

______ School neighborhood

______ Local community (parks, museums, etc.)

______ Outside of local community (specify)

______ Other (specify)

8. Estimate the amount of class time (in hours per week) spent working with:

______ Large groups (entire class or several classes together)

______ Small groups (part of a class)

______ Individuals

9. Does your classroom arrangement include interest centers? If so, what kinds?

10. Do you follow a regular time schedule for teaching each subject? If so, please describe:

11. Do you teach each subject separately or do you integrate several subjects? If you integrate curriculum areas, which areas are most often integrated?

12. Does your class participate in activities with other classes? If so, please describe and indicate how often: _

13. Describe the personnel (professional, parents, para-professional, and district consultants) who frequently work with children in your classroom:

14. Describe or diagram the furniture arrangement in your room (e.g., how pupil desks are grouped and arranged):

15. What are your basic texts in mathematics and science? What additional resource materials do you use in these areas?

16. What subject matter area(s) do you like best to teach?

IMPORTANT NOTE:

Please let us know if your teaching address changes during the summer or if, for some reason, you will not be able to use and evaluate the booklets you have requested.

PROJECT ON ELEMENTARY SCHOOL MATHEMATICS AND SCIENCE
Booker T. Washington School
606 East Grove Street
Champaign, Illinois 61820

TEACHER REACTION FORM
Booklet-Specific

Name of Booklet Being Evaluated____________________________

Teacher's Name____________________ **School**________________

School Address________________________________

Grade Level____________ **Number of Students in Class**____________

How many years of teaching experience have you had at the elementary school level?
_______ (include the present year)

What, if any, auxiliary personnel were available in your classroom to assist you in your work with this booklet? Please specify:

What auxiliary personnel would you like to have had?

Did the implementation of the activities in this booklet necessitate a physical rearrangement of your classroom? Yes_______ No_______
If yes, please describe:

For what grade levels do you feel this booklet is appropriate?

Would you use the activities suggested in this booklet again? Please check your response and comment briefly.

________Yes
________Yes, but with some qualifications
________Undecided at present time
________Probably not
________No

Comments:

DIRECTIONS: Please respond to each of the following questions by using the scale below. First examine the scale and then write the number that most closely expresses your evaluation in the box to the right of each question. If necessary, use the back of this sheet for additional comments. Please number these comments according to the question numbers on this page. Indicate specific page numbers to pinpoint your responses whenever possible.

YES OR ALMOST ALWAYS	USUALLY	SOME OR SOMETIMES	SELDOM	NO OR ALMOST NEVER
1	2	3	4	5

1. Were the descriptions of the activities clear and easy to understand? (If you answered other than 1 or 2, cite specific descriptions that were not clear.) ☐

2. Were the technical terms presented in the booklet easy to understand? (Indicate unclear terms.) ☐

3. Did you find that the integration of mathematics and science activities reinforced learning in both areas? ☐

4. Were the goals of the author(s) clear? (Specify the sections or pages where goals were unclear.) ☐

5. Was learning evident as a result of the activities in which your students participated? (Specify the activities in which student learning was least evident.) ☐

6. Did your students display interest in the various activities in the booklet? (Specify those activities that seemed to be of least interest.) ☐

7. Were the photographs, drawings, charts, and graphs useful? (Indicate those that were not and why.) ☐

8. Were the directions for constructing equipment and/or making learning aids clear? (Cite specific sections where you had problems with the directions.) ☐

9. Did you find it possible to obtain the needed materials? (Indicate those materials hardest or impossible to find.) ☐

10. Was the booklet interesting to read in terms of content and style? ☐

11. Did you find that the activities in the booklet constituted a feasible way to integrate mathematics and science (time-wise, schedule-wise, equipment-wise, etc.)? ☐

12. Did the format and organization facilitate reading and using the booklet? (Specify any problems you encountered with respect to format and/or organization.) ☐

13. Did you find the suggestions for work in other subject areas, such as art, creative writing, social studies, etc., useful? (Indicate those suggestions you did not find to be useful and why.) ☐

* Answer only if applicable to the booklet being evaluated.

DIRECTIONS: Please respond as completely as you can to each of the following questions. Indicate specific page numbers when referring to parts of the booklet. If necessary, use the back of this sheet for additional comments.

1. What major problems did you encounter in teaching from this booklet?

2. What revisions (modifications, additions, deletions) would make this booklet more useful to you? Be as specific as possible.

3. What specific techniques did you use to evaluate your students?

4. If you wish to make additional comments of any kind, please do so below.

For purposes of computer processing of the Teacher Reaction Form data, the numerical values of the ratings on page 2 of the form were reversed so that the most favorable rating became a "5" and the least favorable became a "1". The following "flipped" ratings were employed in all analyses and discussions of the TRF data:

5 = yes or almost always
4 = usually
3 = some or sometimes
2 = seldom
1 = no or almost never

PROJECT ON ELEMENTARY SCHOOL MATHEMATICS AND SCIENCE
Booker T. Washington School
606 East Grove Street
Champaign, Illinois 61820

TEACHER QUESTIONNAIRE, FORM 2

Instructions

On this questionnaire the Project on Elementary School Mathematics and Science is interested in soliciting two reactions from you concerning the way your classroom looks during the study of mathematics and science: (1) the way it looks when you are not using our materials; and (2) the way it looks when you are using our materials.

Part 1: When Project Materials Are Not Being Used

Read each pair of statements on the attached questionnaire and circle the number on the appropriate scale which most accurately describes the study of mathematics and science in your classroom when our materials are not being used. The number "1" corresponds to the left-hand statement; the number "7" corresponds to the right-hand statement; all intermediate numbers correspond to some combination of the circumstances described at the two ends of the scale. If you feel that the description of your classroom falls midway between the two ends of the scale, circle the number "4".

Examine the following criteria to determine which of the three number scales (i.e., M/S, M, and/or S) you should use:

A. If you always teach mathematics and science together (i.e., if mathematics and science are not taught during separate periods as separate subjects), circle the numbers on the M/S scales to describe your classroom during the study of mathematics and science. When reading the statements, the words "mathematics and science" should be inserted in the blanks.

B. If you teach mathematics as a separate subject, circle the numbers on the M number scales to describe your classroom during the study of mathematics. When reading the statements, the word "mathematics" should be inserted in the blanks.

C. If you teach science as a separate subject, circle the numbers on the S number scales to describe your classroom during the study of science. When reading the statements, the word "science" should be inserted in the blanks.

> IMPORTANT NOTE: If you teach both mathematics and science, and if you teach them as separate subjects, you will need to respond to the statements on both the M and the S number scales.

If your school departmentalizes and you serve as a specialist in mathematics and/or science, please omit items 1, 2, and 3.

Instructions continued on page ii

Part 2: When Project Materials Are Being Used

Now, read each pair of statements on the attached questionnaire and mark an "X" through the number on the appropriate scale which most accurately describes the study of mathematics and science in your classroom when our materials are being used. The number "1" corresponds to the left-hand statement; the number "7" corresponds to the right-hand statement; all intermediate numbers correspond to some combination of the circumstances described at the two ends of each scale. If you feel that the description of your classroom falls midway between the two ends of the scale, mark an "X" through the number "4".

Examine the following criteria to determine which of the three number scales (i.e., M/S, M, and/or S) you should use:

A. If you always teach mathematics and science together, and if our materials were used in these classes, place the "X's" on the M/S number scales only. (See example A on page iii.)

B. If you teach mathematics and science as separate subjects, and if our materials were used in both of these classes, place the "X's" on both the M and the S number scales. (See example B on page iii.)

C. If you teach mathematics as a separate subject, and if our materials were used primarily in your mathematics class, place the "X's" on the M number scales only. (See example C on page iii.)

D. If you teach science as a separate subject, and if our materials were used primarily in your science class, place the "X's" on the S number scales only. (See example D on page iii.)

If your school departmentalizes and you serve as a specialist in mathematics and/or science, please omit items 1, 2, and 3.

Instructions concluded on page iii

Examples

The following examples should help you to decide which scale(s) to use when responding to each pair of statements. The responses shown here are to be considered hypothetical. Where appropriate, "X's" may be superimposed over numbers which have already been circled.

A. You always teach M and S together; you use Project materials in M/S classes:

Left-hand Statement	M/S: 1 2 ③ 4 X 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	Right-hand Statement

B. You teach M and S as separate subjects; you use Project materials in both M and S classes:

Left-hand Statement	M/S: 1 2 3 4 5 6 7 M: 1 X 3 ④ 5 6 7 S: 1 2 3 ⓧ 5 6 7	Right-hand Statement

C. You teach M and S as separate subjects; you use Project materials primarily in M class:

Left-hand Statement	M/S: 1 2 3 4 5 6 7 M: 1 2 ⓧ 4 5 6 7 S: 1 2 3 4 5 ⑥ 7	Right-hand Statement

D. You teach M and S as separate subjects; you use Project materials primarily in S class:

Left-hand Statement	M/S: 1 2 3 4 5 6 7 M: ① 2 3 4 5 6 7 S: 1 2 ③ 4 X 6 7	Right-hand Statement

If you wish to comment on your response to any of the pairs of statements, please use the back of the questionnaire and number your comments appropriately.

Teacher's Name____________________ **Date**__________

City____________________ **State**__________

Name of Booklet Used (or Being Used)____________________

Percentage of Activities Completed (e.g., 100%, 65%, 50%, etc.)__________

Statements

Departmental specialists in mathematics and/or science please omit items 1, 2, and 3.

1.	I always teach _____ according to a fixed schedule, i.e., at the same time each day and week.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	I always teach _____ according to a flexible schedule, i.e., there are no specific periods.
2.	The number of hours devoted to _____ each week always varies.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	The number of hours devoted to _____ each week never varies.
3.	_____ in my classroom always overlaps, and is integrated with, other areas of the curriculum.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	_____ in my classroom never overlaps, or is integrated with, other areas of the curriculum.
4.	I always choose the _____ subject matter to be taught to my class.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	The children often choose the _____ subject matter they study.
5.	In studying _____, the class always works individually or in small groups.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	In studying _____, the class never works individually or in small groups.

6.	My children and I feel comfortable working on _____ often in an atmosphere of considerable, but controlled, noise.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	My children and I feel comfortable working on _____ only in an atmosphere of extreme quiet.
7.	I teach _____ exclusively by means of lectures, reading, and/or pencil and paper assignments.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	I teach _____ primarily by means of activities and experiments.
8.	Instruction in _____ in my classroom is based exclusively on one textbook at a time.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	Instruction in _____ in my classroom is based on a great many textbooks, used as resources.
9.	Although some of our _____ study occurs in my classroom, we also make considerable use of the hallways, the out-of-doors, field trips, etc.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	Our _____ study occurs exclusively in my classroom.
10.	All of the equipment and/or materials which we use in the study of _____ are commercially made.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	Much of the equipment and/or materials which we use in the study of _____ we build ourselves.
11.	My _____ approach stresses the products of learning (subject matter) exclusively.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	My _____ approach stresses the processes of learning (observation, classification, etc.) to the same extent as, or more than, the products of learning.
12.	I am primarily concerned that children examine _____ material in depth, even though only a few topics may be covered.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	I am primarily concerned that children cover the _____ material specified by our district's curriculum guide.

13.	If my children are studying just one _____ topic, they will be working on different aspects of that topic at any given time.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	If my children are studying just one _____ topic, they will all be working on the same aspect of that topic at any given time.
14.	In studying _____, I discourage children from interacting with one another and sharing their work.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	In studying _____, I encourage children to interact with one another and to share their work.
15.	During the study of _____ in my classroom, all of the children are studying that subject matter.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	During the study of _____ in my classroom, some children are frequently studying other subject matter.
16.	Professional people (e.g., subject matter specialists and consultants) never assist within my classroom during the study of _____.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	Professional people (e.g., subject matter specialists and consultants) frequently assist within my classroom during the study of _____.
17.	Paraprofessional people (e.g., aides, parents, community people, etc.) never assist within my classroom during the study of _____.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	Paraprofessional people (e.g., aides, parents, community people, etc.) frequently assist within my classroom during the study of _____.
18.	During the study of _____, I am never found at my desk.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	During the study of _____, I am always found at my desk.
19.	During the study of _____, my children are often free to move around the classroom.	M/S: 1 2 3 4 5 6 7 M: 1 2 3 4 5 6 7 S: 1 2 3 4 5 6 7	During the study of _____, my children are never free to move around the classroom.

APPENDIX D

Location of Trial Centers

LOCATION OF TRIAL CENTERS

California (6)*

Mission Viejo
Orinda
Pittsburgh
Santa Barbara
Santa Cruz (2)

Delaware (3)

Bear
Ocean View
Selbyville

Illinois (43)

Albion
Beason
Casey
Champaign-Urbana (24)
Christopher
Decatur (2)
Evanston
Evergreen Park (2)
Highland Park
Joliet
La Grange
Mansfield
Palatine
Taylorville
Thomasboro
Villa Grove
Washington (2)

Indiana (3)

Crawfordsville
Harlan
Indianapolis

Iowa (5)

Iowa City (3)
Sioux City (2)

Maryland

Halethrope

Massachusetts (11)

Newton Highlands
Newton Lower Falls
Quincy (7)
Waban
West Newton

Michigan (2)

Ann Arbor (2)

New Jersey (6)

Allendale
Englewood
Leonia (2)
Long Valley
Oakhurst

New York (8)

Brentwood
Great Neck (3)
New City
Scarsdale (3)

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*Figures in parentheses indicate number of teachers (if greater than 1) used in data analysis.

North Carolina

Monroe

Ohio

Beachwood

Pennsylvania (2)

Latrobe
Philadelphia

Vermont

Bennington

Virginia (2)

McLean
Richmond

Wyoming

Douglas

Canada (7)

Hamilton, Ontario (7)

Saudi Arabia

Dhahran

A BIBLIOGRAPHY OF PUBLICATIONS AND OTHER MATERIALS PERTAINING TO THE PROJECT ON ELEMENTARY SCHOOL MATHEMATICS AND SCIENCE, UNIVERSITY OF ILLINOIS

A BIBLIOGRAPHY OF PUBLICATIONS AND OTHER MATERIALS PERTAINING TO THE PROJECT ON ELEMENTARY SCHOOL MATHEMATICS AND SCIENCE, UNIVERSITY OF ILLINOIS

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    "A Hole in the Wall," by Jane M. Gilchrist
    "Real Structures," by Kurt P. Froehlich
    "An Introduction to Measurement with the Metric System: Mass Measurement," by Richard W. Griffiths
    "Model Cities," by Charles O. Prickett
    "On Flying Kites," by Norbert J. Salz and Harold A. Taylor
    "Shapes with String," by Loren D. Honn
    "Removing the Magic from Multiplication: A Useful Device," by Harold A. Taylor, Barbara A. Francis, and Gregory S. Bell
    "Polyominoes and Paraphernalia," by Gregory S. Bell
    "Water Topics," by Carla Vossler
    "Magic Squares as a Discovery Springboard," by Baharin Shamsuddin

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